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THE

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STEAM PIPES.

IT took marine men a long time to find out that brazed copper pipes were not safe for high pressures, even if they were at all passable for low pressures. A paper by Mr. Milton, of Lloyd's, was read at the late meeting of the Institution of Naval Architects, which appears to show that Mr. Milton, at any rate, is aware of the faults of copper piping. He points out that of numerous accidents to pipes which have been investigated by the Board of Trade, no failure has been proved to be due to original weakness. All have been due either to faulty design, lack of drainage, vibration, or insufficient provision for expansive movements or developed defects. Pipes are usually either of copper or iron or steel lap-welded.

Cast-iron has been used even at sea, and also seamless steel. At one time nearly all pipes were of copper, with longitudinal brazed lap joints. Except in very large pipes, there was but one seam. Up to 6 or 7 inches copper pipes are now seamless. Flanges are usually brazed on. Lack of confidence in copper pipes is plainly indicated by the various systems of lapping with wire or rope or banding at short distance spaces. Copper has been used so much because of its supposed ductility, but ductility may be reduced by impurity or even by treatment and working. Annealed copper is so soft that it will take a permanent set at a stress of 2 tons per square inch, and it will show an elongation in 8-inch specimens of 30 or even 40 per cent. But any less stress than the ultimate of 13 to 14 tons will harden copper, and copper may be thus hardened until its elastic limit is raised from 1·769 tons to 15·56, and its ultimate strength from 13·03 to 16·13, the elongation at the same time being reduced from 48·13 to 17·88 per cent. according to tests by Unwin. Apart from the variation in elastic limit the ultimate strength is practically the same in each case if calculated on the ultimate cross sectional area.

Continual bending and straightening will harden copper wire, while sheet copper may be cold rolled or hammered so, and tubes by drawing to a thinner gauge. Antimony is an objectionable impurity, and bismuth in small traces is very prejudicial. Copper should, if good, stand bending round close with no sign of cracking, or thinning to a knife edge without opening out in edge cracks under the hammer.

Brazing solder is an equal mixture of zinc and copper, with sometimes half of 1 per cent. of tin. Heated red it can be pounded up in a mortar, and this being so is fair evidence that brazing cannot be deemed very safe even at the temperature of modern steam pressures. The fatal accident on the *Prodano*, to which we drew attention a few months ago, is ample proof that though brazing may perhaps

be sometimes found good after years, it is not to be solely depended upon, the zinc, under certain circumstances, passing quite away, and leaving the copper as a spongy mass. Zinc is not a metal that can be depended upon if exposed to chemical action. It is volatile, singularly tender to acid, and generally unsuitable.

For wrought-iron or steel pipes the weld is always a lap, and the welding is done by rolls at one heat in all but the larger sizes of pipe. Free welding iron is preferred to one having mere tenacity, soundness of weld being of first importance. The great advantage of such pipes is that the exigencies of manufacture usually demand a thickness far in excess of that prescribed by the mere pressure to be borne. Such pipes are therefore very likely to be safe, having a large margin. Our own experience of the pipes of the best firms is, that unsound welds are rare, and it is usual to rely on the welds. In steel, however, one sometimes finds, says Mr. Milton, that the weld is reinforced by a riveted cover strip, but experience has shown mild steel to be practically as reliable as iron in respect of its welding property, so that rivets are only a source of possible leakage.

Having so large a margin of strength, such pipes cannot very conveniently be tested to near their elastic limit, but they may be proved to three or four times their working pressure, and it has been proposed to make each pipe a little too long, and to cut off the end and open out and test for soundness of weld. Usually the flanges of these modern pipes are screwed on, but sometimes welded.

Pipes may be had bent to a radius of three bores when below 6 inches diameter, or four bores when from 6 to 12 inches diameter. Mr. Milton states that cast-iron had been used with success in many vessels, and it could be relied on even though a rigid material. Now, cast-iron is not so rigid as wrought-iron. Its extension is greater under stress, and it is an error to speak of its rigidity. The trouble with cast-iron is that its elastic limit is soon reached, and fracture occurs at small deformation, but rigidity is rather an incorrect term to apply. Brittleness would better convey the objections to cast-iron.

The Board of Trade rule for copper pipes is: Thickness in inches $= \frac{P \times D}{6{,}000} + \frac{1}{16}$, P being in pounds per square inch, and D the diameter in inches. For seamless pipes the rule is $\frac{P \times D}{6{,}000} + \frac{1}{32}$. Ordinary practice takes these thicknesses as minima, and bends are made one gauge thicker than would be used for straight lengths, to allow for bending.

Steam at 200 lbs. pressure has a temperature of 388° F. At 300 lbs. the temperature is 422° F. The coefficient of expansion of iron or mild steel for a range of 360° is ·0024, of copper, ·0037. The boiler also, when hot, may stand $\frac{3}{8}$ to $\frac{1}{2}$ inch higher than when cold, and all these causes of movement must be met in the design. Iron pipes are usually allowed expansion joints. Copper pipes will accommodate themselves, but too frequently this ability is frustrated by design. Very severe stresses may be set up, and these appear to be concentrated near to the flanges. Copper pipes thus become hardened near the flanges, and this is shown by the frequent failure by cracking round the pipe near a flange. Mr. Milton asks that pipes of copper should be properly annealed. At present annealing is a partial and perfunctory operation.

When expansion is provided for by special stuffing box expansion lengths, care needs to be taken that the pipe really can move in the stuffing box, and the pipe must be anchored so that movement takes place correctly. The joint may also have proper safety stays to prevent blowing out. This is essential where a bend may happen to allow the pipe to move endwise too freely. But such safety stays are not a part of best design, and if fitted at all should be carefully adjusted so that when cold the safety flange is not tight on the stay whereby it would prevent contraction.

The stays should thus be adjusted cold and the nuts pinned to prevent ill-advised attention. Finally, steam pipes must be so supported as to be free on their supports to move under the influence of expansion stresses. Where a pipe rests on a bracket or roller there ought, we may add, to be placed a friction piece to take the wear due to movement.

Drainage must also be free, so that no water can accumulate in pipes. Dead lengths of pipe are often simply condensers, and become full of water, and cause water hammer action and fractures.

The present Admiralty requirements, said Sir J. Durston, in discussion, were that above 1½-inch pipes should be of steel; below that, of solid drawn copper. Steel pipes up to 9 inches are to be solid drawn. Above that size they *may* be welded, but must then have a butt strap over the weld. Mr. Seaton altogether discarded any idea of depending on the flexibility of copper. He had also very grave doubts of the wisdom of gun-metal or bronze valves, seeing that tin, which forms a part of these alloys, becomes plastic at 410°, and steam may be at a temperature of 420°. The general experience of the speakers who joined in the discussion was all in favour of iron or steel for pipes. Such pipes do not appear either to burst or to corrode, and they must surely engender a feeling of safety which cannot possibly exist with high pressure steam and copper piping, unless such copper is solid drawn, and even then the stresses at flanges are very severe. Flange stress in all pipes is severe, and there must be many cases where greater flexibility would be secured by the method of sockets, the making up lengths being arranged as long threads with back nuts. Should any engineer decide to try socketed and screwed pipes in preference to flanges, we would advise that the pipes be ordered to butt together in the middle of the socket, being faced true on the ends, and a thin joint ring of copper could be placed between the meeting ends.

If desired, all sockets might be back nutted at both ends, and sockets ought, perhaps, to be longer than usual. The pipes of the best English firms, like Jas. Russell & Sons, may perhaps be sometimes dearer than those of foreign makers, but an experience of many thousands of feet of this firm's make has convinced the writer that no foreign makers can surpass them in reliableness and absolute accuracy and interchangeableness. Pipe makers are far too careless as to their diameters. There is a Whitworth standard for the external screwing of wrought pipes which ought to be adhered to as rigidly as is the Whitworth solid ordinary thread. We regret to say some makers do not so adhere to standards, and it is well known that wrought-iron pipes differ so widely as to be non-interchangeable, and some makers do not even adhere to interchangeableness in their own productions.

SIGNALLING ON SINGLE LINE RAILWAYS.

In dealing with the traffic of single lines of railway, many considerations have to be taken into account in connection with the signalling of trains which do not require to be considered in ordinary double-line working. The older form of staff and ticket working is giving way to the more modern method due to the introduction of such instruments as Webb & Thompson's electric train staff, and Tyers' Tablet. The reason for the change is obvious to those acquainted with railway working, and consists in the greater facility for the handling of traffic provided by such instruments as those named, rather than from any increase in the safety of working. Where the old staff and ticket system failed was in the inability to turn a section into either "up" or "down," as circumstances rendered necessary. With any of the forms of instrument now used in preference to the "staff," this desirable result can be obtained, so long as means are taken to counteract the unbalancing of the symbols of authority to proceed, by the preponderance of traffic in one direction, beyond the capacity of the instruments.

On single lines where there is a preponderance of traffic in one direction, either as a whole or for a period only, other points of interest, besides unbalancing of the contents of the instruments, have to be considered. One very important point is the length of the section. Where traffic has to be handled in batches of trains proceeding in the same direction, the shorter the sections are the greater the number of trains which may be travelling at the same time, in the same direction, between two extreme points, such as, for the sake of clearness, the ends of the line. Under the older form of staff and ticket working this was often accomplished by supplementing the staff by "block" working. The last train of any batch carried the "staff," previous trains being each given a ticket. At all points between the staff stations the trains were under "block" rules, and were signalled and stopped or forwarded as occasion might necessitate. The intermediate block stations were, generally, points at which traffic might be picked up or left, but they were not passing places in the sense that trains travelling in opposite directions could pass each other. Practically the combined system was such that the "staff" controlled the *direction*, and the "block" the *passage* of traffic in the section. Obviously there was no limit to the number of intermediate "block" points.

The problems set for solution by the later forms of apparatus for single line working were:—Given a certain number of symbols at each end of a section provide means to ensure that:—

(*a*) One symbol may be withdrawn from the instrument, at either end as may be required, but not more than one, for any one section, at the same time.

(*b*) Symbols for one section shall not be capable of being used for any other section.

Where such instruments are made use of at intermediate non-passing stations, however, there are other conditions that must be satisfied. Under ordinary arrangements, staff sections are entirely independent. At an intermediate station, therefore, it would be possible for the signalman to liberate symbols on both sides of him, and he would thus have two trains approaching from opposite sides on the same line of rails. If the intermediate station is non-passing the results are obvious.

The problems to be solved in such a case are, given three consecutive staff stations provide means for:—

(*a*) Turning the line constituting a staff section into "up" *or* "down" as may be necessary.

(*b*) Preventing the two sections being turned to "up" *and* "down" at the same time.

(*c*) Preventing a second train being sent into a section until the previous train, in that direction, has passed out of the section, although the symbol carried by the first train may have been put into the instrument at the far end of the section.

(*d*) Allowing, under the above conditions, of the free working of the apparatus controlling the second section in the direction in which the train is travelling.

These are the problems which have to be solved in order to safely use the modern form of single-line apparatus at an intermediate non-passing station; and Mr. Hollins, of the Great Eastern Railway, having been asked to design apparatus which would enable these instruments to be used under the conditions set forth above, publishes the results for Tyers' No. 6 Tablet in the March issue of the *Railway Engineer* with the least possible comment.

The means adopted for overcoming the difficulties are ingenious in the extreme, and show great resource in design.

Mr. Hollins attacks the problem on what is, probably, the only vulnerable point for the class of control adopted, and attains his objects by manipulating the main batteries at the intermediate station as necessity may require.

The list of additional apparatus is somewhat formidable, but it is not all used for the purpose of control, although it is indirectly necessary on account of the methods adopted. The following apparatus is all additional to the ordinary instruments and batteries:—

(Intermediate.)

Station "A."	Station "B."	Station "C."
1 5-bar commutator.	2 5-bar commutators.	1 5-bar commutator.
1 telephone "buzzer."	2 telephone "buzzers."	1 telephone "buzzer,"
1 condenser.	2 condensers.	1 condenser,
1 induction coil,	2 induction coils. With circuit breakers.	1 induction coil.
1 battery.	2 batteries.	1 battery.
1 telephone receiver.	2 telephone receivers.	1 telephone receiver,
1 telephone receiver switch.	2 telephone receiver switches.	1 telephone receiver switch.
1 microphone transmitter,	2 microphone transmitters.	1 microphone transmitter.

These are all for purposes such as are usually fulfilled by bells, or gongs, but, in addition, they provide a means of conversation. The apparatus specified below is all at station "B" and constitutes the locking and releasing apparatus.

4 rail treadles.
4 rail treadle line wires,
4 rail treadle batteries,
1 press key.
1 press key battery.
3 polarised electro-magnets operating 3 switches,
2 plunging contacts.
2 contacts operated by position of indicators,

Briefly stated, Mr. Hollins arranges the apparatus so that when the line is required to be prepared for the entrance of a train at, say, station "A," the usual manipulation of the instruments not only releases the symbol at "A," but breaks down the main battery at "B" working, for the purpose of release, to "C." This is effected by the action of either "B" or "A" independently, and there are, therefore, two chances against failure. Since, for the section "B"—"C," for trains from "C" to "B," "B" is the controller, there is no possibility of the section B—C being made a "down" section, say, during the time the section A—B is an "up" section.

During the time the train is between "A" and "B" things remain as described. On arriving *near* "B" the train passes over a rail treadle which is provided with a separate battery and line wire to an electro-magnet operating a switch contact in the cabin. *Under normal conditions* no change is made by the current set up at this treadle, the direction of the current being such through the electro-magnet as to *close* the contact operated by the latter. Passing a little further the train, *before reaching the cabin*, operates a second rail treadle, the current from which passes through the electro-magnet already referred to, and causes the latter to *open* the switch operated by it. *This contact governs the use of both "B's" main batteries* to "A" and "C," and the *opening* prevents "B" from performing any operations involving the use of those batteries. This control is in addition to that obtained by the manipulation of the instruments between "A" and "B" to obtain the entrance of the train at "A."

When the train arrives at the cabin the signalman may obtain the symbol from the driver, and may even insert it in the proper instrument, but, owing to the action due to the second rail treadle, he cannot clear the section back to "A" until the train has performed further operations.

The construction of Tyers' No. 6 Tablet, which is the instrument illustrated, is such as to allow of a tablet being withdrawn without the aid of the local battery operated by the signalman. Hence, although "B's" main batteries are broken down, he is able to obtain a tablet for the train to proceed to "C," with the concurrence of the signalman at that point.

Continuing the consideration of the progress of the train; as it proceeds from the cabin towards "C" it passes over a third rail treadle, which, like the second, acts to *open* the

switch operated by the electro-magnet. This third current from rail treadles has, therefore, no effect other than has already been produced. Passing on still further the train operates a fourth treadle which *closes* the switch. The train, however, is then past all signals controlling entrance to the section B—C, and is therefore clear of section A—B.

The two main batteries at "B," which were broken down by the operation of the second treadle, are now reconnected, so far as the switch considered is concerned. The main battery to "C," however, is still broken down as the result of the operations to enable the train to enter the section at "A." All that now remains to be done is to restore the section A—B to the neutral condition. This is done by "A" replying to the signal indicating the clearance of the line.

Besides the four treadles operating the switch governing *both* main batteries at "B," a press key and battery are shown in connection with the line wire of the two closing treadles. This key is presumably in the cabin, and is apparently intended for use in case of failure of the last treadle for any one train. It is not, however, so stated, and is not referred to in the text.

Careful consideration of the arrangements, generally, show how fully the conditions formulated for working to an intermediate non-passing station have been met, and with what ingenuity the usual points of the design of the apparatus have been utilised. Attention may, more particularly, be drawn to the division of control between the actual instruments used for ordinary working, and the position of the train.

Further consideration would seem to indicate the existence of a weak link in the chain, from the provision of the press key in the cabin. Given a train at "B," anywhere between the *closing* treadles, but not on either of the opening ones, it would seem to be possible for the signalman, after obtaining the tablet brought by the train, and before obtaining one for the advance section, to, by using the press key, accept a train from either one or the other of the stations on each side of him. Of course, this would be an unusual course for him to take, but accidents are always the result of unusual circumstances.

Consideration of the diagram shows that for the purpose of operating the switch in connection with the treadles and press key, three of the five batteries used might be dispensed with by putting the other two in between the instrument circuits and their respective lines. Of course, the reason for the arrangement shown may be the fact that an earth fault on the line wire of the closing treadle circuit might prematurely release "B's" main batteries, if the treadle batteries were in the positions indicated.

Of the arrangements for the use of a telephonic call in lieu of the usual bell or gong it is unnecessary to remark, as they are in no way connected with the safety of working further than that the change seems to have been necessary in order to carry out the scheme of re-arrangement. The arrangement of the apparatus is very ingenious and, probably, is the first instance of the application of condensers and "shocking coils" to railway signalling.

Consideration of the conditions necessary for the safe working of such cases as are under notice, shows that there are other points from which the question of effective control may be approached. In ordinary double-line signalling, the signalman at any cabin is prohibited from accepting an "Is line clear" signal from the rear cabin when the "Home" signal at the advance cabin is less than 400 yards ahead, until the signalman at the advance cabin has accepted the same signal from him. In some cases the line wire of the rear section is carried through to the advance cabin so that the signalman there may know what is being done and act as a check against error. In one special case the line wire is carried to two cabins in advance of that at which it would ordinarily stop. The application of such a rule to the changing of either of the two sections working to an intermediate, non-passing, single-line staff station, *from the neutral condition*, would have all the weight it now has in the operation of double lines, and the means necessary to ensure that the line constituting the first section, for the time being, shall not be cleared to the rear cabin until the train is under the protection of *all* the signals at the intermediate point need be very simple. Such a rule is already in force for sections of line containing *two* consecutive non-passing staff stations, but it is capable of extension.

Considered in connection with through traffic, *i.e.*, traffic which does not require to stop at the intermediate station for purposes of its own, intermediate staff stations are distinctly inferior to the "block" stations which, under the older system were established for similar reasons, in that such traffic has, necessarily, to lose time in order to exchange symbols. That system will ultimately prove the best which combines the absolute safety of the older form of staff and ticket, combined with block working, for dealing with traffic in batches, with the facilities for change of direction of traffic provided by the more modern forms.

HEAT AND LIGHT.

By W. S. HEDLEY, M.D.

At the present moment there is a sort of "heat wave" passing over some branches of medical practice. It is a matter of observation that in certain painful and disabling affections, whether of the muscular, articular, or nervous structures, the application of the highest temperature that the part can bear (250° to 350° F.) is often attended with excellent results. Once the impulse has been given, all sorts and conditions of heating apparatus have been promptly supplied, varying from a glorified poultice in the shape of the electrotherm, or of hot air imprisoned in a metal box, to the fierce energy of direct luminous radiation. Medical men are bewildered in their choice, but on the whole they show a tendency to adhere to the traditional principle of the poultice; in other words, to apply heat by means of some hot medium, forgetting, perhaps, that no such medium is necessary, and that heat travels not by the air, but by the ether, or, more strictly speaking, that heat radiation is not a transference of heat, but a transference of energy, which becomes heat on encountering a body in its path.

This heat wave in medical practice is nothing new. It is one of many such waves that have followed each other in more or less regular succession, both in ancient and modern times. Confining our attention to the present century, the first of these waves originated in the practice and precepts of a certain Dr. Gosse, of Geneva, who, in 1826, published a book on rheumatism, "Des Maladies Rheumatoides." He there refers to heat as "the soul of the treatment," and insists that all other remedies are of secondary importance. Of course, he calls heat "caloric," and speaks of it as an "imponderable and incompressible fluid." It is evident that *he*, at least, had no idea of radiation; still his practice was fairly up to date. The next such wave, and one of a far greater amplitude, occurred about "the sixties," when Mr. Urquhart, under the auspices of many eminent medical men, introduced the Turkish bath into England, or more correctly speaking, re-introduced it after it had fallen into disuse for 15 centuries. It is to be remembered that for the first three centuries of the Christian era something very similar had flourished in England under Roman rule. The Turkish bath needs no description. Its mode of heating by hot air blasts and radiation from heated plates, and its temperatures varying from 120 to 240 F. in its hottest rooms, are known to all. Shortly after this a more localised form of bath, hot air boxes and "steam box baths," became common in hydropathic and similar establishments. The direct descendant of these hot air boxes is a copper cylinder, heated by gas jets placed underneath it, which was brought to notice about seven or eight years ago. It began by being "air tight and steam tight," but early in its career these requirements were discarded, and it now offers itself only as a means of applying "superheated air" to various parts of the body, although it still retains its steam pressure gauge and sundry mysterious taps and valves, whose *raison d'être* is not quite evident now. It easily reaches a temperature of 250 F. and more. But amongst its drawbacks was a very serious one, viz., the necessary proximity of the patient to so large a number of gas jets, which, by their imperfect combustion, seriously contaminated the air, and often prostrated the patient. With a view, amongst other things, to obviate this drawback, I then used an oblong rectangular box, made of electrical heating plates (Crompton's), with enamel insulation. This was a great improvement in convenience and comfort, but

for the following reasons I soon discarded it. Tyndall has proved the far greater intensity of heat when the heat proceeds from a luminous source. By investigating the radiations from the obscure band of the spectrum in the case of a platinum wire gradually heated to incandescence, he has shown that as the light rays are added, the heat rays become more intense. I ascertained that this principle had been made use of in electric cooking, and at once adopted and adapted the apparatus. The heaters are Mr. Dowsing's "heat lamps," with his reflector. Each lamp takes 2 to 2½ amperes, and four to six such lamps are sufficient to apply a radiant heat bath to the whole body. By this means a temperature of 350 F. is quickly shown in a thermometer placed midway between two heaters 12 inches apart. With luminous heat to begin with, it is obvious that by suitable screening and diffusing arrangements, any other form of heat can be easily obtained, either the ordinary direct radiation of the luminous filament, or any special part of the spectrum (*e.g.*, red) or obscure radiation from a metal plate or heated air. Such an apparatus is easily adapted to any part of the body, or to the whole body.

Another electrically heated apparatus which has lately been brought to notice consists of a metal case or receptacle or box of a variety of shapes and sizes, containing in its interior naked platinoid resistance wires stretched on supports. Apart from the fact that naked wires must prove a source of inconvenience and danger, and that they seem to carry back electrical heating to the crude attempts of 20 years ago, it is evident that such an apparatus must rely chiefly on heated air, and that, therefore, according to the foregoing views, it is constructed on entirely wrong lines.

With the foregoing points in my mind, I was not a little interested and surprised in reading Mr. Urquhart's book on the Turkish bath a few weeks ago to find that I had been, to some extent, anticipated. He seems to have fully appreciated the difference between "conducted heat" and "rays of heat." Having described how, in Berlin, his attack of rheumatism had not been cured by a temperature of 150, he had his couch dragged directly in front of a large German stove. The thermometer then rose to 175, and the relief of his symptoms immediately followed.

The following is an extract from page 33 of his book:—"At this time I attributed the result to the difference between 150 and 175, I have since seen that the difference lay much deeper, having been brought up close to the stove merely for increase of heat, an unexpected effect followed. The body was exposed to the *rays of heat*. These rays have distinct properties from transmitted heat, as I have since discovered."

About the same time a certain Mr. Scriven, in one of his reports, speaks of the greater curative value of "rays from a red-hot stove." That such views were not followed up was probably owing to the then practical difficulty of getting any manageable form of luminous heat. We now have the advantage, which they had not, of being able to utilise substances incandesced by electricity.

The influence of light (apart from heat) upon vegetables and animals has always been an interesting problem. It is a matter of common observation that a plant deprived of light grows sickly, ceases to fructify and dies. Onimus experimenting on vineyards found that if part of the ground were covered, thereby diminishing the light although increasing the local temperature, the grape did not there come to maturity. The action of light upon the vegetable cell is to fix the carbon and hydrogen as cellulose, chlorophyll, and fatty matter by decomposing carbonic acid. In other words, the energy of light is transformed into the energy of disassociation, chiefly in separating oxygen from carbon. Experimenting on vegetables with the electric arc it has been found that although this light increases growth and hastens maturity, it is hurtful if brought too near or continued too long. Its effects seem to be due to the rays on the right of the spectrum, whereas really it is the least refrangible or calorific rays that most largely influence vegetable nutrition.

There is an old saying that "where the sun does not enter disease does," in other words, the microbicidal power of light has long been recognised. Buchner, investigating the influence of light upon bacteria, found that water containing about 100,000 bacilli to the cubic centimetre, failed to furnish a culture after having been exposed to sunlight for an hour. It has also been shown that light has a distinctive action on the poison of diptheria. A similar effect upon certain other bacilli has also been noticed, and the various kinds of light show in this respect a decreasing power in the following order:—Sunlight, arc light, acetylene gas, incandescent lamp, petroleum gas, diffused daylight; even the candle is not without a certain bactericidal power. But whilst giving due weight to the foregoing points, it must not be forgotten that light increases the virulence of certain microbes.

Whereas in the vegetable kingdom the action of light effects reduction processes, the *animal* body under the action of light oxidises the elements furnished by the vegetable, decomposing them into carbonic acid and water. Further, whilst it is the least refrangible or red rays of the spectrum that influence the reducing processes in the vegetable, it is generally considered that it is the violet and ultra-violet rays that influence the processes of oxidation. Every tissue of the body is permeable to light—skin, muscle, tendon, bones. Light penetrates the tissues, and is stored up there.

It is not difficult to prove that physiologically light influences the nervous system, the nutrition of the cell and the composition of the blood. I have systematically used the agency of light, arc lamps taking 20 to 50 amperes. It will improve anæmic conditions and favourably influence nutrition; it will diminish pain in neuralgia, sciatica, and lumbago, and it is useful in rheumatism. It is also stated that concentrated light will favourably affect ulcers and lupus. The two latter, perhaps, by the ozone produced by the arc. It is well known that an arc lamp in action will effectually disinfect certain unsavory places. It is stated, but I have not verified the point, that electric welders are comparatively free from rheumatism. At the same time we all know, and no one better than the electrician, that the electric light has a good deal to answer for in the production of ophthalmia in the shape of injury to the retina, and to the cornea, with reflex effects on the conjunctiva. This is the work of the violet or ultra-violet rays, and therefore it has been proposed to obviate the evil by the use of uranium glass, which, becoming fluorescent, changes the more refrangible or actinic rays into waves of a different length.

The injurious effect of sunlight upon the skin is also a matter of common observation and a most interesting point. But, apart from direct experiment, it is not always quite easy in dealing with the animal body to separate the effects of heat and light.

Perhaps light absorbed by the body may partly become heat, the shorter wave lengths of light being "degraded" into the longer wave lengths of heat. This question has been dealt with by Dr. Bowles in his interesting study of the effects of sunlight on the skin.*

March 21st.

THE PESCETTO STORAGE BATTERIES.

Yet another high-capacity accumulator, this time hailing from Turin. We are as yet unable to give details as to the leading features of construction in the new cell—or cells—for there are three forms of it, devised for different applications. But we have before us the catalogue and price list of the Società Italiana di Elettricità già Cruto, which, by reason of the extent of the information it puts forward, is quite a new departure in accumulator price lists. This company, with a paid up capital of nearly £100,000, is the concessionnaire for the Pescetto patent, and, judging from its catalogue, it appears to have set about its work in a very thorough way. The catalogue, we may mention, is in the French language.

The close and apparently accurate information which is given in this carefully and tastefully got up *brochure* relative to the available capacity of the three forms of the accumulator—and more especially that devised for traction—under very varied conditions, must be taken as constituting to a certain extent the credentials of the new accumulator. This information, in fact, almost compensates for the absence, *pro. tem.*, of the details of construction; for we may assume that the apparatus is essentially a lead accumulator,

* Part of the above is from a paper by the present writer on "The Therapeutics of Heat."

à oxydes rapportés, and with a sulphuric acid electrolyte, and its performance is a proof that the details in question have been carefully worked out.

The three kinds or forms of the accumulator are :—

Form P.—Station batteries for charge and discharge at normal rates, specially intended for lighting.

Form P R.—Station batteries for rapid discharge, specially intended for the distribution of electric energy and as regulators for large stations.

Form R P R.—Batteries for rapid charge and discharge, specially intended for traction.

The first category comprises batteries from 1 P to 35 P, of which the weights (which, by reason of the odd spongy lead plate, are not simply multiples of the weight of 1 P) and the prices are given. Then the rate of discharge, in amperes, and the capacity in ampere-hours, are given for each battery, under six different conditions, viz, when the rate of discharge per kilo. of plates is ·8, 1, 1·25, 1·50, 1·75, or 2 amperes, the corresponding periods of discharge being 13 hours 40 minutes, 10 hours 42 minutes, 8 hours 24 minutes, 6 hours 51 minutes, 5 hours 54 minutes, and 5 hours. In this form of battery the rate of charge is constant, at 2 amperes per kilo. of plates. The values given indicate a comparatively flat curve of rise of capacity with time of discharge, and also a comparatively very high ratio of capacity to weight for a stationary battery. Thus, taking the capacity per pound of plates in the case of the battery 10 P, this varies as follows, according to the above-mentioned periods of discharge :—

5, 4·86, 4·80, 4·67, 4·60, and 4·54 ampere-hours.

Users of the battery, however, will naturally want to know the capacity per pound of cell complete, which, as we have previously insisted, should always be given in catalogues like that under consideration. The required information may be found by reference to a separate table, which informs us that, the weight of plates in the battery 10 P being 14·5 kilos., that of "l'Elément avec Bac" is 23·24 kilos. The weight of the electrolyte is given as 9 kilos., and if we add this to the preceding weight, we obtain 32·24 kilos. as the weight of the battery complete with electrolyte. These figures, however, give a very low ratio of weight of plates to weight of battery, viz, $\frac{14{\cdot}50}{32{\cdot}24} = {\cdot}45$; so much so, that we are inclined to think that "l'Elément avec Bac" must really signify "Battery with receptacle and electrolyte." In this case the ratio would be ·624., *i.e.*, somewhat higher than that of the E.P.S. "L" or "T" cells. This ratio, and the fact that the proportion of electrolyte is unnecessarily high, are not of real importance in stationary accumulators, but are nevertheless of some interest in considering a new cell.

Formulæ are given for calculating the rate of discharge and the capacity required in a battery to work a given number of incandescent lamps of given candle-power for a given number of hours; so that, by referring to the table, the purchaser can select the battery most suitable for the work.

The second category, that of stationary accumulators for rapid discharge, gives particulars of batteries from "8 P R" to "35 P R" under six different conditions of working, viz., when the discharge takes place in 4 hours, 3 hours 16 minutes, 2 hours 45 minutes, 2 hours 23 minutes, 2 hours 5 minutes, or 1 hour 52 minutes. The rates of discharge per kilo. of plates corresponding to these periods are 2·5, 3, 3·5, 4, 4·5, and 5 amperes. The maximum rate of charge is 3 amperes per kilo. of plates.

Using British units, for the sake of more ready comparison, the useful capacity per *pound* of plates corresponding to the above periods and rates of discharge are :—

4·54, 4·45, 4·39, 4·31, 4·28, and 4·25 ampere-hours.

Approximately, these values apply to all the "P R" cells; but they are derived from the battery 27 P R. For a rapid discharge battery—and a discharge in less that two hours, or even within 4 hours, brings it within that category—these values are undoubtedly high. We may add that the ratio between weight of plates and weight of cell complete may in this case be taken as ·6, and that the time capacity curve of this cell is remarkably level, a fact which shows that the active material is sufficiently accessible to the electrolyte, and that the rates of discharge are not so high as to "distress" the cell.

Of paramount interest, at the present moment especially, is the R P R, or rapid charge, as well as rapid discharge, cell, specially designed for traction. Let us at once say that the ratio of weight of plates to weight of cell complete is in this case as high as ·76, the battery comparing well in this respect with the Fulmen and "Chloride" traction cells. The table in which the capabilities of this form of cell are set forth is very extended and comprehensive, and may well be taken as a model for future catalogues of traction cells. Seven batteries—from "1 R P R" to "7 R P R"—are quoted; and, for each of these, four data are given under nine different conditions as regard rate and time of charge, and under five different conditions as regard rate and time of discharge. Each battery of from one to seven sets of plates can thus be studied under 45 different aspects. In addition to this, the table gives the utilisible watt-hour capacity per kilo. of plates (multiply by ·76 for watt-hours per kilo. of complete cell), the weight of plates necessary to give one kilowatt-hour or B. of T. unit of energy, and the weight of plates necessary to give 1 kilowatt or B. of T. unit of power.

Taking the lowest rate of charge, viz, ·91 ampere per pound of plate, or ·69 ampere per pound of battery complete (or, what is the same thing, the highest period of charge, viz., 7½ hours) the capacities per *pound* of plates, corresponding to five periods of discharge are as follows :—

Time of discharge ...	5 h. 36 m.,	4 h. 35 m.,	3 h. 52 m.,	3 h. 20 m.,	2 h. 55 m.
Ampere-hours	6·36	6·25	6 12	6 07	5·98

Going to the other extreme, and taking the highest rate (and lowest time) of charge, viz., 9·1 amperes per pound of plates, or 6·9 amperes per pound of cell (the period of charge being then only 15 minutes), the capacities per pound of plates for five different periods of discharge, in the case of the 7 R P R battery, are :—

Time of discharge ...	1 h. 36 m.,	1 h. 18 m.,	1 h. 6 m.,	0 h. 57 m.,	0 h. 50 m.
Ampere-hours	1·83	1·78	1·76	1·73	1·717

It is a question whether it can be advantageous to employ accumulators under conditions in which the apparent capacity becomes reduced to a mere fraction of the normal capacity; but these figures, which apparently can be depended upon, must be of interest from a theoretical, if not from a purely practical point of view.

We propose in our next issue to give some particulars as to the construction of these batteries.

THE ALTERNATING CURRENT ARC.

The experimental demonstration last Friday at the Institution of Electrical Engineers of the results of Messrs. Duddell and Marchant on alternating arcs, printed in the last number of the *Journal*, will not easily be forgotten by anyone who saw it. Apart from its own extreme interest, it was an admirable pendant to Mrs. Ayrton's paper, immediately preceding it. The Council of the Institution are to be congratulated on the success of their recent arrangements for reading together groups of papers on the same or closely allied subjects, as was done with the three on wireless telegraphy, and with these two on the arc. Mrs. Ayrton's paper and that of Messrs. Duddell and Marchant mutually assisted and illustrated one another, and the interest of each has been greatly increased thereby. To those of our readers who have not seen the paper, nor were present at the demonstration, we may explain that the authors have worked for some years investigating the circumstances of alternating electrical currents through arcs, and have brought this paper describing their results to the Institution of Electrical Engineers.

Several of the most important properties of alternating current arcs have been made known by previous observers, among whom M. Blondel has been, perhaps, the most indefatigable worker, and the present paper begins with a short notice of others on the same subject which have already been published. For the purposes of their investigation the authors desired to ascertain the wave forms of three quantities, viz., the alternating electromotive force imposed on the circuit, the potential difference between the carbons, and the current through the arc. Besides these, the character of the rest of the circuit and the dimensions of the arc were also

noted, but the interest of the paper lay mainly in the records for different arcs of the above three-wave forms. It is, of course, by no means the first time that the forms of such curves have been obtained, and rather more than a year ago we fully described an instrument designed by Prof. E. B. Rosa, and exhibited before Section A of the British Association at Toronto, which he employed for plotting curves of the kind. The results of this instrument are of a very high order of accuracy, and the best yet obtained by the method, which is that of plotting together a series of points of known phases obtained from different waves by a succession of separate adjustments. In the case of a steady wave form, repeated without any change an indefinite number of times, so that the value of the ordinate at any given phase is the same in each period, this method leaves little to be desired. In the case of the arc, however, the present authors soon found that the wave form, though stable, is not steady, and that no curve built up point by point from different periods could be accepted as representing the wave at any one time. Moreover, it was necessary for their purpose that all three wave curves should be recorded together. Another consideration that led them to the course they ultimately adopted was one of time. Life seemed hardly long enough to investigate all the cases they had in view with a point by point construction. These circumstances drove them to the oscillograph, an instrument which has been already used for this purpose by M. Blondel, but on account of irregularities introduced by the instrument itself has not been hitherto regarded as accurate in comparison with the point by point curve tracers of Joubert and Rosa. The oscillograph is a galvanometer whose deflection always represents the instantaneous value of the current, and to do this the moving part has to follow closely and without the slightest delay the most rapid and violent, as well as the minutest, changes in the current. A description of the mode in which these conditions were met is given in the paper, with illustrations of the construction of the apparatus. It will be sufficient here to say that they have obtained a most satisfactory instrument. A new one just completed by the Cambridge Instrument Company was exhibited, though not used, at the meeting, and was said to possess much better qualities than the ones the authors had in use. The accuracy of this last had been proved by the close agreement of the continuous record of a steady alternating current obtained by it, with points plotted by the method of M. Joubert. The sensitiveness of the instrument is such that small irregularities of the main curve whose periods do not exceed one five-thousandth of a second were clearly shown on the screen. Three beams of light reflected from a mirror revolving in unison with the alternating source, and then from the mirrors of the oscillograph, gave on the screen at the Electrical Engineers' meeting three continuous lines. One straight and horizontal was the zero line of reference, the axis of the wave curves, and the other two were periodic wave curves giving the values of the current through an arc under examination, and the potential difference between the carbons. An enlarged image of the arc itself was thrown on another screen, so that the whole performance could be easily followed by the audience. It is difficult to convey an adequate idea of the striking character of the demonstration. The curves published in the *Journal*, though valuable records, are merely dry bones, and lose all the literally palpitating life of those shown on the screen. The latter were like living animals compared to the skeleton and the stuffed skin of the printed paper. The sight of these wave lines constantly changing in form and yet always perfect and continuous was most fascinating. Among other effects the authors were able to show the gradual changes in the wave forms while the arc was being lengthened; and the sudden flash of the current curve to the zero line, and of the P.D. curve of the carbons up to P.D. curve of the distribution system at the instant when the arc broke was most striking. The applause of the meeting was evidence of a degree of interest and appreciation that must have been very gratifying to the authors.

We do not like to leave this subject without commenting on one or two of the more striking results. The most remarkable point about the P.D. curve of an alternating arc is the flat top, descending from and ascending to a sharply defined peak at each end, while the flat part, or plateau, is the seat of constant little irregular wavy movements. This seems to show that along the flat part the arc is really a hissing arc, using the term in what we believe to be Mrs. Ayrton's sense of an arc is which energy is transformed at constant difference of potential. The sharp drop in the P.D. of the carbons from the peak on to the undulating plateau, as well as the steep ascent to the closing peak, seems to have some bearing on the point, as Mrs. Ayrton's hissing arcs were always obtained with a drop of 9 or 10 volts from a previously existing silent arc. They were, however, always the result of admitting oxygen to the crater, and it is not clear how this can occur in these alternating arcs. Hissing arcs are, moreover, much less steady than silent arcs, and the existence of irregularities on the line of the plateau lends some support to this view.

Of all the curves shown, that which elicited most applause was between carbon and an alloy of zinc. In this the current is purely unidirectional, and no current can pass through an arc which has zinc as the positive electrode. The fact is well known. Zinc arc dischargers have proved to be of the greatest possible value in saving overhead power lines from destruction in lightning storms; but a demonstration on the screen that not only cannot an arc be maintained with a positive zinc electrode, but that actually no current at all passes during that half of the period when the zinc is positive was most striking. In this part of the period the P.D. curve of the arc was identical with that of the supply circuit, and the current curve with the zero line. In the other half of the period, when the carbon is positive, the P.D. curve of the arc had the usual flattened character, and the current curve resembled a distorted sine curve.

Since this paper was read we have seen M. Blondel's paper on oscillographs given before the French Association for the Advancement of Science at the meeting at Nantes last year. This has much interest in connection with the present subject, and we hope to print some account of it shortly.

LEGAL.

The Castner-Kellner Alkali Company, Limited, *v.* the Commercial Development Corporation, Limited.

In the Court of Appeal on 13th inst., before the Master of the Rolls and Lords Justices Rigby and Vaughan Williams, judgment was given in the appeal by the defendants in this action from an order of Mr. Justice Bigham, who had granted an injunction with respect of the alleged infringement of letters patent granted to Mr. Carl Kellner for an invention of improvements in the electrolytic apparatus for decomposing alkaline salts. The businesses in question were carried on at Manchester, Birmingham, Liverpool, and elsewhere, and the defendants, whilst denying infringement, contended that the plaintiffs' patents were bad for disconformity. It was submitted on their behalf that Kellner's patent was bad because though it differed from a prior patent, Castner's, it involved no substantial invention within the statute of monopolies, nor was any substantial increase of utility shown over Castner's patent.

Mr. T. Terrell, Q.C., Mr. Astbury, Q.C., Mr. McConkey, and Mr. J. H. Gray appeared in support of the appeal, and Mr. Fletcher Moulton, Q.C., Mr. Bousfield, Q.C., Mr. J. Graham, Mr. A. J. Walter, and Lord Robert Cecil were for the respondents.

The Master of the Rolls, in giving judgment, said that the action was brought for infringement of patent, but it was brought under very unusual circumstances. In the first place, the plaintiffs' patent—Kellner's, 1894—has never been used for any commercial purpose, nor, indeed, at all, except, perhaps, by way of experiment. Its non-use was not explained by the fact that, although new and novel, it had been superseded by a later invention. But such was not the case. The patent sued upon had not been used because a prior patent belonging to the plaintiffs had been found to answer their purposes better; but this prior patent was not relied upon by the plaintiffs in the action. In the next place, the defendants had not yet begun work, so that no infringement in fact, by what they actually did could be proved. They had, however, constructed some apparatus according to another patent—Rhodin's, of 1896—and they had admitted that they intend to use the apparatus. But it was obvious that if in practice it were found desirable to depart from some of the directions contained in that specification, such departure might have a very material bearing upon the question whether the defendants really infringed the plaintiffs' patent. His Lordship made this observation because Rhodin's specification referred to the slow rotation of one of its component parts, whereas it seemed plain that much better results were obtained by quick rotation of the same part. If the defendants' apparatus were at work, his Lordship was satisfied by the evidence that the part to which he was referring would be rapidly and not slowly rotated. But if this were so, the effects produced would be so different, that the question of infringement would, in his opinion, assume a totally different aspect. Again, when the defendants began to work, they might find it better to keep what were called their bells stationary, and to rotate the trays and troughs

in which they stand. They were under no obligation to work precisely as told by Rhodin. But if such modification were made, the question of infringement would be totally different from what it was if they were to assume that the defendants intended to make no departure from the directions contained in Rhodin's specification. Again, when comparing the processes described in Kellner's and Rhodin's specifications, Mr. Terrell made a very important admission in favour of the plaintiffs. He admitted that if there was no distinction between a rotary movement and a to and fro movement described in fig. 1 of Kellner's specification, then there was no practical distinction between his apparatus and theirs. This admission was not referred to by Mr. Justice Bigham, and it is very important as plaintiffs' patent is for an apparatus and not merely for a method for making soda. But to treat this admission as an admission by the defendants, as they would use it, will necessarily amount to an infringement of the plaintiffs' patent, even if it was valid, appeared to him to be pushing the admission much further than was just to the learned counsel who made it, or to his clients who would suffer the consequences of it. He passed then to consider the first point which arose in this case, and that was the nature of Kellner's invention as disclosed in the specification. The invention was for an improved apparatus, and the real nature of that invention was quite clear. It was an apparatus for making an open-mouthed vessel containing an electrofied solution of salt over a stationary layer of mercury covered over fresh water. The vessel is to be moved in such a way that the electrofied salt solution shall be in contact with part of the mercury for a time, and then be shifted to another part, which, whilst the mercury is acted upon by the salt water and converted into an amalgam of mercury and sodium, or be brought into contact with the fresh water so as to decompose the amalgam into mercury and soda in solution. That was Kellner's invention, and, so far as he could judge, it was novel and useful. Kellner showed in his provisional specification one mode of carrying it out, namely, by a to and fro motion of the vessel or bell containing the salt solution, but it was quite competent for him to point out in his complete specification any better method of presenting the mercury first to the salt water and then to the fresh provided he kept the mercury as quiescent as possible. His last point, therefore, was one of the essential features of his invention, the means of having a stationary mercury cathode, the shifting of the bell, and the non-shifting of the amalgam formed in it, the care taken to make openings in the lower ends of the bells so as not to displace the mercury, and the descriptions showing how to work the apparatus whilst the mercury cathode itself remained at rest, so that the aim of the founder was to keep the mercury as quiet as possible consistently with the moving of the bells of salt water over its surface. This was very important in order to distinguish Kellner's invention from Castner's prior invention, in which the mercury was moved rapidly from the mouth of one compartment containing salt water to the mouth of the other containing fresh water. His Lordship had carefully studied Kellner's specification and also the evidence of the experts called on both sides, and notwithstanding what was said about there being no practical difference between moving a bell through mercury and moving mercury under a bell, he was satisfied that any process by which the mercury was intentionally moved or disturbed otherwise than to the least possible extent by moving bells of salt water over it was outside, and not fairly within Kellner's real invention had disclosed in his original specification. There he differed with Mr. Justice Bigham. His Lordship did not attach importance to fig. 6 in the complete specification, in which the position of the salt water and the fresh water were reversed. That was a modification consistent with the real invention described in the provisional specification. Further, he was not prepared to hold (especially having regard to the admission made by Mr. Terrell as already mentioned) that the mere substitution of a rotary motion for a to and fro motion of the bells would not be equally within Kellner's invention as described in his provisional specification, provided always care were taken to keep the mercury still, but the claim No. 3, and figs. 7 and 8, to which it referred, was, in his opinion, an entire departure from the essential feature of his invention as originally described. Here the mercury was intentionally not kept as still as possible, but might be moved and disturbed to any extent. This was quite inconsistent with the original idea. An invention for an apparatus for keeping the mercury still was not an invention for an apparatus for keeping the mercury moving. Claim No. 3 covered both inventions, and was such a departure, and such an extension of Kellner's real invention, as to render the patent sued upon invalid as it stood. Very possibly the defect could be cured by a disclaimer, but whether when so cured the patent would be infringed by the defendants it would be quite improper now to decide. If he was right in thinking that the defendants' apparatus could not be worked with advantage unless the mercury was kept in rapid motion and not kept as still as possible, the plaintiffs would be well advised to reconsider their position before they commenced a fresh action on an amended specification. In his opinion the judgment ought to be reversed and judgment entered for the defendants, with costs, and the plaintiffs must pay the costs of the appeal.

Lord Justice Rigby said he proposed in his judgment to deal exclusively with the question of the validity of the patent sued upon, Kellner's of 1894. If, as in his opinion was the case, that patent could be shown to be invalid, it would be an academic question whether on the supposition of its being valid there would be an infringement, and he did not propose to enter into the question at all. The grounds alleged for holding the patent invalid were disconformity and want of subject matter. He should deal mainly with the first of these, which depended upon a comparison of the provisional and complete specifications according to the true construction of each. This construction was entirely for the Court. Experts, however eminent, had nothing whatever to do with it, though their evidence might be valuable in explaining the meaning of technical terms, the state of the invention at the date of the patent, and the working of the apparatus described. The main point for consideration would be the meaning of the words "stationary mercury cathode," which paraphrased meant a stationary cathode composed of mercury, otherwise a stationary mercurial cathode, or a cathode composed of stationary mercury. He had come to the conclusion that the first was the true meaning differing in this respect from Mr. Justice Bigham, who adopted the second. The difference was crucial, because the second meaning was the only one which rendered it possible, however difficult, to take further steps, which Mr. Justice Bigham had taken, for interpreting in a manner different from its ordinary meaning what his Lordship took to be "stationary" with reference to surrounding unmoving objects, and he attributed to it a very different and exceptional meaning of "stationary" with reference to the containing vessel. In his judgment it was not only startling but quite inadmissible to say that the ultimate development of an invention which must rely for its validity upon an inventive departure from a pre-existing state of things would be to bring them back to precisely that pre-existing state of things as was done by the claims in figs. 7 and 8 of Kellner, when the bottom of the chamber was rotated. Mr. Moulton did not attempt to grapple with any of these difficulties. Indeed, it very soon became plain that he had no intention of grappling with them. His conclusion was that the actual modification of apparatus exactly described and claimed in figs. 7 and 8. At any rate, when the bottom containing chamber was made to revolve under the cells rigidly connected with one another was not a legitimate development of the invention, the nature of which was shown by the provisional specification, and that the patent was therefore void for disconformity. That was the main ground of his decision as to the invalidity of the patent. Going to the question of subject-matter, even if it could be shown that the objection of disconformity failed there would remain that of want of subject-matter. Comparing figs. 7 and 8 of Kellner's with fig. 1 of Castner's patent, they found in that modification of 7 and 8, viz., the motion with which the cells remained still and the bottom alone was made to rotate, an exact correspondence between Castner and Kellner up to the point where the question arose how to move the mercury cathode. Castner effected this by a stirrer, consisting of helical blades mounted on a rotating shaft passing down the apparatus. All that Kellner did was to substitute for this rotating stirrer a rotation of the bottom of the vessel containing mercury. There was no clear evidence of any advantage over Castner in this arrangement. Further, the modification introduced by figs. 7 and 8 by moving the bottom of the vessel, so far from being shown to be an important improvement in practice from former apparatus, had never been used at all, and there was no evidence of experience or even experiments that it would practically work at all as a commercial success. In his judgment the Kellner patent was void from want of subject matter, so far as concerned the particular modification of apparatus which had been dealt with, and the claim No. 3 founded thereon, and therefore the whole patent was void on this ground also.

Lord Justice Vaughan Williams said that he had the misfortune to differ from the other members of the Court, and as he did not think that the Kellner patent was bad from disconformity, he regretted to say that he should necessarily have to go into the whole question both of the merits of the Kellner patent and of the alleged infringement of the Kellner patent by the Rhodin patent. In order to deal with the case, it was necessary to make some comparison of the plaintiffs' patent and prior letters patent, and in particular a prior patent taken out by Castner. The main features of the Castner patent seemed to have been (1) a single chamber divided into two sections, one for salt and water and one for pure water, by a partition not extending quite to the bottom of the vessel, and sealed by the mercury at the bottom of the vessel; (2) a continuous electric current passing through both chambers; (3) the adjustment of the proportion of amperes passing through the chambers respectively by a division of the continuous current; (4) the change in the location of the mercury relatively to the two chambers by the flow of the mercury round and round the containing vessel produced by the propulsion of paddles attached to a central revolving shaft; (5) the maintenance of an average minimum of ·2 per cent. of sodium throughout the mercury by the churning produced by the propelling paddles. The idea of Kellner seemed to have been this:—He had a large dish with mercury at the bottom. On the top of this mercury he had movable cells, with the lower edge just dipping into the mercury so as to seal the bottom of the cell and prevent any liquid which might be placed inside the cell running out at the bottom. These cells he filled with salt and water. The whole of the vessel outside these cells he filled with pure water, so that the whole of the mercury which was not covered by the salt and water contained in the movable cells was covered with pure water. He electrolysed the salt and water by a current passed through the salt and water to the cathode formed by the mercury. This current was not continuous, and did not, as in the case of Castner's patent, pass on through the pure water. He then by shifting the bells containing the salt and water electrolyte about on the surface of the mercury caused patches of the mercury to be alternately covered by the salt and water electrolyte and the pure water respectively, thus charging with sodium the patch of mercury covered by the salt and water electrolyte and discharging of sodium the same patch of mercury when subjected to the pure water by the shifting on of the cell containing the salt and water to the adjoining patch, which, prior to the shifting had been covered with salt and water. In order that the shifting of the cells should not by reason of the dipping of the lower edge or lips of the cell into the mercury carry with it the patch of mercury which was under the cell at the time of the shifting of the cell, Kellner made in the lower edge of the cell a series of notches or openings or serrations. The mercury in Kellner's apparatus had

no fluid motion, or at least was intended to have none relatively to the vessel containing it. The Kellner apparatus had no continuous electric fluid, not even an adjusted continuous current passing through the pure water cell. In Kellner's provisional specification the motion of the cell containing the salt and water electrolyte was a to and fro motion. In the complete specification he made several additions which his counsel called "developments of the invention, identified by the provisional specification," but which the opposing counsel contended were "departures from the provisional specification amounting to disconformity." These were the substitution for the to and fro movement of a rotary movement of the cells on the top of the mercury, and also the substitution as an alternative method of the rotation of the dish containing the mercury, instead of the movement, whether to and fro or rotary, of the cells on the top of the mercury. The other addition made in the "complete specification" was the addition of a short-circuited current in the pure water cell starting from the mercury amalgam acting as an anode. This the defendants relied upon as another instance of "disconformity," and also relied on it on the question of utility, alleging that the apparatus would not act without it, whereas the plaintiffs said that the "short-circuited current" was only to be used in case it was desired that the alkaline metal should be rapidly removed from the formation. The principal feature of the Kellner invention seemed to be (1) the substitution of non-circulating mercury for flowing mercury; (2) the subjection of the surface patches of the still mercury alternately to salt and water electrolyte, and pure water respectively; (3) the manufacture as far as possible of the mercury in a still condition free from agitation. The idea of the Rhodin patent seemed to have been to adopt the Kellner idea so far as it related to the movement of the salt electrolyte in a rigid vessel over the top of a stationary cathode, but to modify it so as to enable the use of a stronger electric current than that which could be used with the Kellner invention.

Dealing with the defences set up in the action, his Lordship said that he thought the view taken by Mr. Justice Bigham as to the meaning of the words in the Kellner provisional specification, "stationary mercury cathode" was right. It was clear that prior to the Kellner patent inventors had always tried to get over the difficulty arising from necessity of quickly taking away the mercury when charged with the sodium deposited by electrolysis by causing the mercury thus charged to flow in a vessel containing it—the earlier inventions caused the mercury to flow when changed into a separate vessel or chamber where it was discharged of the sodium, by contact of the amalgam with pure water, sometimes assisted by an electrical current passing through the second as well as the first chamber, and sometimes with the current passing only through the salt and water in the first chamber. Castner made the mercury flow in a single vessel underneath two rigid chambers, part and parcel of the same vessel. He read the word "stationary" as qualifying the word "mercury," and the words "stationary mercury" qualifying the word "cathode." The various defences set up by the defendants were these:—(1) Denial of infringement; (2) denial of the validity of the patent on the ground (*a*) of want of novelty by reason of the anticipations set forth in the particulars, (*b*) want of subject matter, (*c*) want of utility, (*d*) want of invention, (*e*) disconformity. With regard to the defences of disconformity and denial of infringement, which his Lordship considered together, it was said that the complete specification departed from the provisional first because figs. 7 and 8 introduced the rotary instead of the to and fro movement. It seemed to his Lordship that there was nothing in this, because if the invention of Kellner consisted of moving about a rigid body over stationary mercury in the sense in which he read those words, it seemed to him to be a legitimate development to say that in addition to movement by the "to and fro" method the movement of the chamber over the stationary mercury might be attained by the rotary movement of the chamber over the stationary mercury, or by the rotation of the mercury dish over the chambers. In either case there was no flowing of the mercury relatively to the dish containing it. He thought that Mr. Justice Bigham was right, and that there was no disconformity even in the case of the rotation of the bottom dish, because the mercury, even in this case, was stationary relatively to the dish containing it. As to the suggested disconformity, by reason of the claim in respect of the third electrode in the combining chamber, his Lordship thought there was nothing in it because it was limited by the words at the beginning of claim 4, "In apparatus of the kind specified in preceding claims." His Lordship further thought that assuming as he did that claim 3 was not bad for disconformity, assuming, that is, that there was no distinction between the rotary movement and the to and fro movement, the infringment by the defendants of the Kellner patent was clearly established, even apart from important admission of the leading counsel for the defendants, an admission which, for his own part, his Lordship thought he was right in making. Indeed, if it were not for the denial of Rhodin he should have thought it tolerably clear that Rhodin's patent was framed by someone with Kellner's and Castner's patents before him, seeking to extract the best portions of both. The total combination in the Rhodin apparatus seemed to his Lordship very different from the total combination in the Kellner apparatus. The result was arrived at by the application, in part, at all events, of very different principles, but if Kellner's patent claimed, as his Lordship thought it, the use of stationary mercury relatively to the vessel containing it, and divided chambers, one of which was rotary, he thought that there was a clear infringement, and not the less so because Rhodin might have improved upon Kellner's apparatus by applying it to a novel and more effective apparatus. Dealing with the defence of anticipation, his Lordship said that the only anticipation seriously urged was the Castner process. It was said that the Kellner patent was anticipated by the Castner because the movement of the chambers above the mercury was a mere mechanical equivalent for the flow of the mercury under the chambers. He (his Lordship) thought, not having regard to the object in view, Castner wanted to produce churning of the mercury; Kellner wished to avoid it. Castner's process did produce churning; Kellner's, to a large extent, avoided it, and was intended so to do. Then it was said that Castner's double chamber was an anticipation of Kellner's double chamber. His Lordship thought that Castner's double chamber was fixed, and a part of a single structure. Kellner's was detached and movable, being, in fact, one of two rigid structures. Then as to the defences of want of invention, want of utility, and want of subject matter, which more or less hanged together in his Lordship's opinion, all failed. He thought there was sufficient ingenuity to constitute an invention entitled to a patent, and that the invention was not only ingenious but useful. It offered a method of producing caustic soda with a low electric current by dealing with surface patches of sufficiently still mercury, and that he considered was a distinctly new method. He came to the conclusion that the plaintiffs' apparatus was proved by the evidence to have sufficient utility as affording theoretically a novel alternative mode of producing caustic soda by an electrolytic mercurial process. For these reasons he thought the judgment of Mr. Justice Bigham right.

The appeal was then allowed in the usual way.

Mr. Terrell, Q.C., for the defendants, asked that the particulars of objections should be certified, for otherwise there would be a difficulty with the taxing master in allowing them.

A long discussion followed, with the result that their Lordships admitted that they were not so conversant with these matters as the courts of first instance, and decided that the matter should be mentioned to them again at some later date, when they had made inquiries on the point.

Ashwell & Nesbit, Limited, *v.* Stanton.

In the Queen's Bench Division of the High Court of Justice yesterday, before Mr. Justice Wills and Mr. Justice Ridley, sitting as a Divisional Court, this case came on for hearing.

Mr. Manisty appeared for the appellants and Mr. Ernest Pollock for the defendant.

Mr. Manisty said this was a motion by Mrs. Stanton to set aside the findings and judgment of Mr. Pollock, the official referee, in an action tried before him at Leeds, by which he gave judgment for the plaintiffs on their claim for £500, and for them on the defendant's counterclaim. The action was brought by the plaintiffs, who were manufacturers of electric light and heating apparatus at Leicester and Nottingham, to recover £500 in respect of work done under two contracts. The defence was that the work had not been completed in accordance with the terms of the contract, that the work as done was defective, and further, there was a counterclaim that the work was done on the terms of an express assurance given by the plaintiff that the work should be completed on November 4th, 1897, so as to enable the defendant to open certain business premises in Leeds on that date, and that relying on the faith of that assurance, she incurred much expense in advertising the opening of the premises, &c., and the work was not completed by that date. Mrs. Stanton carried on various extensive businesses as a retail bootmaker in Liverpool, South Shields, Darlington, Nottingham, Middlesborough, Derby, and other places, and she contemplated opening new premises in Leeds. She accordingly acquired a site and erected large premises, expending some £22,000. She entered into contracts for electric lighting and heating with the plaintiffs. The premises were not ready until December, and the electric light until December 10th.

Their Lordships suggested that the parties should settle the case amicably, and after a consultation, Mr. Pollock said that his friend had met him and said he might keep his judgment on the claim for £500, and they left the question about the difference in amount between two dynamos to an engineer.

An argument then took place with regard to a question of insurance, and final judgment was reserved on another minor point of law *sine die*.

The National Company for the Distribution of Electricity by Secondary Generators, Limited, *v.* John Dixon Gibbs and Henriette Onesime Ruelle (the wife of Sylvain Jean Baptiste Ruelle and the Administratrix of Lucien Gaulard.)

This case came before Mr. Justice Cozens-Hardy in the Chancery Division on the 17th and 18th inst., and was an action brought by the plaintiffs for specific performance of two agreements of May 25th, 1883, and October 31st, 1888.

It appeared that by the agreement of May 25th, 1883, made between Lucien Gaulard and the defendant Gibbs, the vendors of the one part and the plaintiff company, it was agreed that the vendors should sell to the plaintiffs the exclusive privilege of using and vending certain inventions in connection with the manufacture and construction of secondary generators for the distribution of electricity and other apparatus connected with electric lighting for which the vendors had obtained letters patent in the United Kingdom, France, Belgium, Italy, Austria, Spain, New Zealand, India, Canada, Victoria, New South Wales, Queensland, South Australia and Tasmania, and also all the said letters and patents and privileges and the benefit of certain inventions and improvement for the sum of £220,000 to be paid as to £200,000 in 20,000 shares of £10 each of the plaintiff company, fully paid up, and £20,000 in cash. It was further agreed that the vendors should, at the expense of the plaintiff company, establish a title to the inventions and letters patent and privileges and should transfer the same to and cause the same to be legally vested in the plaintiff company, and that the assignments to the plaintiff company should contain a covenant by the vendors that

all the letters patent were valid and all such other covenants as might be required by the plaintiffs for giving effect to the sale. By a further agreement of October 31st, 1883, made between the vendors of the one part and the plaintiff company of the other part, the former agreement was altered and varied so that the vendors should be paid by the plaintiff company in lieu of the £20,000 in cash a moiety of the moneys to be realised by the plaintiff company from licenses or concessions or agreements of any kind to use or work the inventions in question until such moiety should amount to the sum of £10,000, and the further sum of £1,000 residue of the sum of £20,000 cash in 1,000 preferred shares of £10 each, fully paid up. The plaintiffs alleged that they had allotted to the vendors the shares in question, and had paid to the defendant Gibbs £984 in cash, and to Gaulard £1,788 in cash in pursuance of the agreement, but that the letters patent and privileges had not, in fact, been transferred to or assigned to the plaintiff company, nor were the letters patent and privileges, in fact, valid. The plaintiffs also said that various persons had taken proceedings in France, the United States, Germany, and Austria impeaching the validity of the letters patent and privileges granted in those countries, and as a result of those proceedings the letters patent in respect of the United Kingdom had declared to be void the Brevets d'Invention in respect of France, Germany, and Austria had been declared to be invalid, or restricted to such an extent that the remaining claims were of little or no value. The plaintiff company had paid a large sum in respect of costs, which they asked that the defendants might be ordered to repay, and also for so much of the purchase money paid to the defendants by them (the plaintiffs) as was properly attributable to the patents which had been declared to be wholly invalid, and of a due proportion of so much of the purchase money as was properly attributable to the patents which had been declared to be partially invalid.

Mr. Fletcher Moulton, Q.C., and Mr. Gore-Brown appeared for the plaintiff company, and Mr. Eve, Q.C., and Mr. Rowden for the defendants.

Mr. Fletcher Moulton said that Gibbs and Gaulard were people who were very well known in the early stages of electric lighting as partners in the system of distribution. The plaintiffs estimated that the value of the patent by what had taken place were reduced by £50,000 in the United Kingdom. The learned counsel said that by the Gibbs and Gaulard invention it became possible to distribute electricity over very much larger areas than it was possible to do by the direct current, and which enormously diminished the expense of electric light installations by copper. That was the fundamental patent for the distribution of electricity by secondary generators. If the patent was valid, the whole of the persons setting up installations by secondary generators would have had to take patents from the plaintiffs. At the present moment one-half of the installations over England were by this system, and by this system the reduction of cost of installations would be something like 25 per cent. His Lordship would see that the value of the fundamental patent controlling the whole of that was enormous. If he (counsel) said that that patent was worth £1,000,000 he should not be exaggerating.

His Lordship: What is the defence?

Mr. Eve said that the defence was that there had been a release by the joint contractor, and that the action could not be maintained. The defendants also said that the thing was *res judicata*. His Lordship would find that as long ago as 1884 the parties chose to appeal to the French jurisdiction, and the case was subsequently dealt with by the French Courts, and he thought he should show his Lordship that all the points raised in the present action were decided in the French action. The last defence set up was that the plaintiffs had not carried out their part of the agreement. The defendants also counterclaimed for the amount found due to them in the French proceedings.

His Lordship: Is there any point about the joint covenant?

Mr. Eve said there was, and he thought it would be convenient to deal with that point before the witnesses were called.

Mr. Moulton said that he did not think that that defence was pleaded.

His Lordship said that if the point arose on the documents, there was no reason to plead it. He thought that the point went to the whole root of the action, and that he ought to hear counsel upon it at once.

A long legal argument then followed as to whether when letters patent were granted to two persons, and one died, the grant passed to the survivor. Mr. Fletcher Moulton submitted that the grant of letters patent to two persons was such a grant, that if one died his executor took all his rights under the patent. The first thing they had to look at was the nature of the property before they began to consider the words of the grant for a grant of that kind, the analogous of joint tenancies and tenancies in common were utterly inapplicable.

Further arguments upon the point having been addressed to his Lordship by Mr. Gore-Brown, Mr. Eve and Mr. Rowden, his Lordship said he would consider his judgment on it.

The further hearing of the case was adjourned till after judgment on the point raised was given.

Ashley *v.* Pickup & Co. and Price.

Before Mr. Ambrose Jones, sitting as arbitrator under the Workmen's Compensation Act, in the Bury County Court on 13th inst., the case of Samuel Herbert Ashley, of 22, Grove Street, Rochdale, *v.* J. H. Pickup & Co., Limited, electrical engineers, of Bury, and Harry Lloyd Price, of 79, Mosley Street, Manchester, was heard.

Mr. Cockcroft, who appeared for the applicant, said that at the time of the accident the applicant was working on a planing machine. Two of the applicant's fingers were cut off while he was at work, and it was alleged that at the time the machine had a defective mandrel. He earned 5s. a week for playing a kettledrum in the Rochdale Philarmonic Society's Band, but was no longer able to hold the drumsticks. He claimed £223 13s. 10d., the cost of a life annuity of 5s. per week, and £7 loss of wages.

The Arbitrator eventually made an order for the payment of 8s. per week (half the applicant's wages) from September 22nd last, and 5s. per week to be paid to him during the term of his permanent incapacity.

PARLIAMENTARY COMMITTEES.

North-West London Railway Bill.

Mr. Jeffreys presided on Thursday last week over a Select Committee of the House of Commons to consider the North-West London Railway Bill. The object of the Bill is to empower the company to construct underground railways to be worked by electricity from the Marble Arch to Cricklewood.

Mr. Balfour Browne, Q.C., who with Mr. Shaw and Mr. Hutchinson appeared for the promoters, explained the clauses of the Bill. The proposed line, he said, would be four miles in length, and there was no opposition as far as he knew from the local authorities whose districts the line would traverse. The only opposition, he believed, came from the London County Council. The idea was to connect this railway with the Central London Railway being constructed along the Bayswater Road and past the Marble Arch to the City. The line would also connect with the Baker Street and Waterloo Railway now being constructed. The capital powers would be £1,500,000 and borrowing powers of £50,000. It was estimated that the line would cost £1,065,183. The trains would be such as to accommodate 350 people, and the lifts to be provided at the stations—viz, at the Marble Arch, Edgeware Road, Hall Road, Kilburn, Brondesbury, and Cricklewood—would raise 250 people at a time. The object of the London County Council in opposing the Bill was to get the company to insert clauses forcing them to carry workmen at unremunerative rates and at hours of the day which the company contended was not suitable for workmen's trains, but which, on the other hand, would allow clerks and others well able to pay the ordinary fares to travel at workmen rates. While the company desired to cultivate workmen's trains, yet they wanted those trains to be run at proper hours and for the fares to be remunerative. The company proposed the following list of fares:—From Cricklewood to the Marble Arch, before 7 in the morning, the return journey to be made any time during the day, 2½d.; from Cricklewood to Kilburn, 1½d. return; and from the Marble Arch to Kilburn, 1½d. return. The County Council wanted the fares to be made 1d. for the single and 1½d. for the return journey, but if the clauses were insisted upon the company would be unable to raise its capital.

Mr. Freeman, Q.C., who appeared for the London County Council, said that after further consideration the County Council had agreed to accept 2d. instead of 2½d. as the return fare, and 1d. as the single, both applying to any distance.

Mr. Balfour Browne said that another contention of the County Council was that workmen's trains should be run up to 8 o'clock in the morning. If this was done many persons well able to pay would be carried at cheap rates.

A number of witnesses were called in support of the Bill. Sir Henry Oakley expressing the opinion that the line would return a minimum of 3 per cent., while Sir Benjamin Baker stated that the line would cost £450,000 a mile.

The Chairman said the Committee had decided to allow the return fare of 2½d., the single fare of 1½d., and the intermediate fare of 1½d., but the hours for workmen's trains should be extended from 7.30 to 8 o'clock.

The various clauses of the Bill were then considered, and those affected by the decision of the Committee allowed, and the Bill was ordered to be reported to the House.

Kensington and Notting Hill Electric Lighting Bill.

The above Bill, promoted by the Kensington and Knightsbridge Electric Light Company and the Notting Hill Electric Lighting Company, was arranged to be considered by a Select Committee of the House of Commons on Monday, but on Saturday the opposition of the London County Council was withdrawn, and the Bill consequently was reported as unopposed. The power sought for in the Bill is to enable the two companies to unite in building a generating station on land at Wood Lane, Hammersmith. There will be separate capital in the shape of a joint guaranteed stock, and the two companies will pay for the current they take at prime cost, after providing for the sinking fund which will redeem the whole of the cost in 31 years, the station to belong to the companies in proportion to the amount paid by each.

Baker Street and Waterloo Railway.

On Monday Mr. Jeffreys presided over a Select Committee of the House of Commons to consider a Bill by the Baker Street and Waterloo Railway to extend the authorised railway from Baker Street to Paddington and St. Pancras. Mr. Pember, Q.C., Mr. E. Page, Q.C., Mr. W. J. Noble and Mr. Shaw represented the company; Mr. Lewis Coward was for the Vestry of St. Martin's-in-the-Fields; Mr. Balfour Browne, Q.C., Mr. E. Moon and Mr. A. Neilson were for the Grand Junction Canal Company; Mr. Freeman, Q.C., and Mr. Clode

represented the Gordon Hotels Company; Mr. T. W. Wheeler represented Mr. A. Tatham and Miss Tatham; Mr. Littler, Q.C., Mr. Balfour Browne, and Mr. Freeman, Q.C., represented the Metropolitan Railway Company; the Ecclesiastical Commissioners and the Great Western Railway Company, and the Metropolitan Electric Supply Company, reserved an appearance; Mr. Worsley Taylor represented the Charing Cross, Euston and Hampstead Railway Company; and Mr. Freeman and Lord Robert Cecil appeared for the Paddington Vestry. Other opponents of the Bill received an appearance.

Mr. Page, Q.C., in opening the petitioners' case, said the object of the Bill was to obtain power to make certain extensions of the Baker Street and Waterloo Railway, an electric railway which was sanctioned by Parliament in 1893, and also to provide for an extension of time for the completion of the railway. The Act of 1893 authorised the construction of an underground line from Baker Street to Waterloo. The capital was £1,250,000. In 1894, owing to the fact that the Great Central Company was then known to be coming to London, an extension of the line was authorised westward, stretching to Harewood Square. That was for the purpose of enabling the railway to communicate with the Great Central station at Marylebone. At that time Parliament thought fit to extend the time given by the Act of 1893 for the purchase of the necessary land and the completion of the works authorised. The object of the present Bill was to authorise some small but important extensions of the lines authorised in 1893 and 1896, and also to authorise a still further extension for the time limited by Parliament for the completion of the line. The proposed extensions were (1) a line which, in the first place, passed from Harewood Square to Paddington station, for the purpose of forming an underground communication with Paddington station, which would then pass on in a north-westerly direction, ultimately reaching a point close to Portsdown Road, where a station would be formed where carriages could be kept when not in use; (2) an extension starting from the neighbourhood of Portland Road Station to Euston, the object of that being to form a communication with Euston, so as to enable passengers arriving at that station to find their way to or from Waterloo Station. There was another small extension to the South, or, rather, an alteration, which was rendered necessary in consequence of the arrangements which were requisite for the purposes of the Waterloo and City Railway. He did not think that alteration was opposed by anybody. It really was a deviation more than an extension of the powers which Parliament intended to give to the company in 1893. At Paddington it was proposed that there should be a subway, and that subway the Bill asked Parliament to authorise. Another subway was at Trafalgar Square, and as to that there was a certain amount of opposition. In 1893 the intention was that a station should be formed in the neighbourhood of Trafalgar Square close to Spring Gardens. The site which Parliament then authorised to be taken was found to be inconvenient, and, he believed, not sufficiently large, and therefore the idea had been abandoned of forming a station there, and in lieu thereof it was intended, if Parliament granted powers to make an underground station at Trafalgar Square and the necessary subways from that station reaching to the surface. The particular subway which was objected to there was one which would come out just at the corner of the Grand Hotel. He believed the London County Council approved of the position at which that subway would emerge, but the Gordon Hotels Company, which owned the Grand Hotel, objected to it, mainly on the ground that some small portion of the underground cellars at the hotel would be interfered with. As a matter of fact he believed the subway would only touch about 4 or 5 feet of the hotel cellarage. The proposed Trafalgar Square subway would be an advantage not only to the company but to the public. The next object of the Bill was to obtain an extension of time both for the acquisition of the land and the completion of the undertaking. For the acquisition of the land they asked for an extension to March, 1899, and for the completion of the undertaking to March, 1904. The reason this extension was asked for was because in the early days the people had little faith in electrical underground railways, and it was not deemed advisable to go to the public. A sum of £300,000 had been spent on the railway, and the tunnel under the Thames had advanced till, he believed, the northern side of the river was already reached, and besides that the necessary land for the different stations had been acquired. The people who had spent the £300,000 were the London and Globe Finance Company, of which the Marquis of Dufferin was chairman, and he would also be the chairman of the railway company. The Bill asked for power to raise £1,400,000. In addition to the cost of the line there would be subways to Euston and elsewhere, and it was proposed to erect an extensive generating station south of the Thames which would be capable of providing the necessary electrical power for the whole of the line. It would be impossible to devise a railway which would afford greater direct communication from the Great Northern lines through London to the south. The first petition against the Bill was the Charing Cross, Euston, and Hampstead Railway Company, whose principal ground of objection was to the competition between Euston and Charing Cross. Incidentally it might be that the line would compete between these points, but that was not the main object of their Bill. The North-Western Railway were in favour of the Bill. The reason why the Ecclesiastical Commissioners had reserved an appearance was because they were the freeholders of land on which they proposed to erect the Paddington station, but he believed they would not oppose. The objection of the Gordon Hotels Company was to the subway at Charing Cross, but that subway could do no damage to the Gordon Hotels Company. The outside interference with the cellars of the tenants of the company's shops in Northumberland Avenue would be about 3 feet.

The Chairman: Will the subway be open to the public?

Mr. Page said the public could use the subway to cross the street, similar to that of the Central London Railway at the Mansion House. The line proposed to pass some distance under the Grand Junction Canal at Paddington, but there was no intention to interfere with the working of the canal. He was told that the Great Western Company were not opposing the Bill, but, on the other hand, were anxious to see the connection made with Waterloo. The only object of the appearance of the London County Council was to try and get special provisions made for cheap trains. The company asked to be left under the general law. The opposition from the Metropolitan Electric Supply Company had been practically settled. The objection of the Metropolitan Railway Company was to the competition which would be caused, and they stated that from their experience there was not sufficient traffic to make the undertaking remunerative. The Paddington Vestry objected to the proposed terminus station and workshops as being injurious to the neighbourhood. The main objection of the Vestry of St. Martin's-in-the-Fields was to the proposed Charing Cross subway.

At the conclusion of the opening statement the Committee adjourned till Tuesday.

The consideration of the Bill was resumed by the Select Committee on Tuesday.

Mr. Fredk. Harrison, general manager of the London and North-Western Railway Company, said he had made himself acquainted with the proposed route of the Baker Street and Waterloo Railway. There was a considerable traffic of passengers between Euston and Waterloo which his company dealt with by omnibuses. They had through fares with the London and South-Western Railway. There was formerly a service from Willesden to Waterloo, but generally passengers crossed London. The proposed line was bound to give great relief to the street traffic of London. His company would like to see the line come to Euston, as suggested, as it would be a great convenience to passengers. The directors of the London and North-Western Company were willing that a subway should be made to Euston Station.

By Mr. Freeman, Q.C.: At the present time the Euston, Charing Cross and Hampstead line was authorised, but that did not give communication with Waterloo.

Re-examined, Witness said that the scheme of the Euston, Charing Cross and Hampstead line had been about for years, but nothing had been done with it, he believed. The proposed line would give access to Piccadilly.

In reply to the Chairman, Witness said there would be arrangements made for the transfer of luggage.

Mr. Wilkinson, general manager of the Great Western Railway Company, said he had gone carefully into the question of the proposed extension of the line to Paddington. His company hailed the extension with great satisfaction, as it would be a great convenience to their passengers. The line would open up Clubland, and the West End shopping districts and the theatres to their passengers. He thought that the Great Western Railway Company would bring up at least 1,000,000 passengers per year who could use the proposed line, and that was an increasing number.

By Mr. Littler, Q.C.: He would not admit that the new line would be in competition with the Metropolitan Railway. In regard to the working agreement between the Great Western Railway Company and the Metropolitan Railway Company, he contended that there was an arbitration clause in that agreement, and if there was any dispute between the companies it would be a domestic matter between the two companies, and not one to trouble the Committee with. With regard to the cost of making the new railway, it must be remembered that the making of these underground railways was a new undertaking, and the promoters must necessarily work to some extent in the dark. He could not tell why the proposed capital of the company should be so large. His company was advised that in giving facilities to the new railway there was no breach of the agreement with the Metropolitan Railway Company.

Mr. W. Pollitt, general manager of the Great Central Railway, gave similar evidence as to the convenience the railway would be to passengers coming to the Marylebone Station, and particularly the advantage it would be to them to get direct to Paddington.

Mr. Owen, general manager of the London and South-Western Railway Company, said the traffic to and from Waterloo had increased from 18,000,000 in 1888 to 28,000,000 in 1898, and a large proportion of that traffic went west. The new line would be an enormous advantage to the public. The Waterloo and City Railway, which had only been open 4½ months, had carried 1½ millions of passengers, while the number would have been greater if there was more rolling stock.

Sir Benjamin Baker gave evidence of his connection with the undertaking. He said he was not responsible for the laying out of the line, but he was originally called in to give an independent estimate of the cost and see whether there was a sufficient margin between the Parliamentary estimate and the capital for the other things which had to come out of that margin. He had been thus associated with all the other electrical railways. He asked that Messrs. Vigers and Sons should be associated with him in respect to the property. He devoted some time to the investigation, and as a result he found that the cost of the works was a little high and he reduced his estimate of the cost; but, on the other hand, his estimate of the electrical traction and the general fittings of the line was increased, and Mr. Vigers' estimate for the property was increased. The London and Globe Finance Company was a very large finance corporation, and had made itself responsible from time to time for several great works. The estimated cost of the railway was £575,000 per mile. Contracts had been made for the construction of the authorised portion of the undertaking, and steps had been taken to acquire the necessary property. They were sinking the shafts for the Piccadilly Circus Railway. With regard to the extensions asked for in the present Bill, they found that the people of Paddington were opposed to having the generating station in that parish, and so they had made

arrangements with the London and South-Western Railway Company to have a site on the south of the Thames. With respect to the line going under the Grand Junction Canal at Paddington, it was ludicrous to say that there would be any engineering difficulties or any danger in tunnelling under shallow water like that. As to the proposed depôt at Paddington there would be no nuisance to the inhabitants.

The Chairman: There would be no steam engine works there?

Witness said there would be nothing of the kind. It was necessary to have a place for washing the carriages and so on.

Mr. Pember: It will be their dressing room in fact?—Yes.

The Chairman: Will the machinery necessary for repairs be driven by electricity?—Yes.

Continuing, Witness said the subway for Charing Cross was not in the original Bill, but was suggested by the public subways at the Mansion House. The subway at Charing Cross would be similar in principle to the Mansion House subway. There would be free access to the public to the subways.

By Mr. Littler, Q.C.: The railway went beyond Euston to Seymour Street, but that was for a back shunt.

Mr. Littler: There is nothing to prevent you going on to St. Pancras and Pentonville, and joining with your railway the City and South London extension?—Well, I am really much obliged to you for the suggestion. It never occurred to me before.

Further cross-examined by Mr. Littler, Witness said he was not aware that the Central London Railway failed to obtain its capital from the public. He was told that Mr. Whittaker Wright, of the London and Globe Finance Company, had not publicly stated that the company would get £800,000 out of the Baker Street and Waterloo Railway Company, but that the company would get that out of the railway and other undertakings.

By Mr. Freeman: He first became actually concerned in advising the company immediately the London and Globe Company started with it; that was about 18 months ago.

The Committee adjourned.

CORRESPONDENCE.

The Cost of Supply to Single-phase Motors.

The interesting article with the above title in your current issue sums up very concisely the main points connected with the operation of present-day single-phase induction motors. But one of the most important points was not referred to, namely, the effect of the starting of these motors upon the regulation of the supply system, and, incidentally, upon the temper of the central station people.

Within the last two or three years the present writer has had occasion to professionally examine and report upon quite a number of single-phase motors of various designs and sizes, and has come to the conclusion that, generally speaking, central station engineers are by no means eager to have a motor load of this nature upon their circuits, and, moreover, in some cases they actually discourage it. Now it cannot be denied that such a state of affairs is highly undesirable, and it becomes very necessary to see exactly why it should be. The first reason, in the opinion of the writer, is due to the large wattless starting currents that modern single-phase motors invariably take, even when running up on the very necessary loose pulley, and the cause of this is due, in fully 75 per cent. of the troublesome cases, to the policy of the motor makers in retaining the pure short-circuited form of rotor for too many sizes. To illustrate what is meant, a concrete example may be quoted. A 50-cycle motor of, say, 5-H.P., and having a squirrel cage or similar rotor, can be quite well designed to run up to full speed with its belt and loose pulley at a current consumption not much exceeding the full load current. If this same motor has a wound rotor, that is, if the rotor conductors are connected up as a three-phase star winding with the three ends brought to slip rings on the shaft, and if a non-inductive resistance is used in each phase at starting in the well-known manner, the motor will not only run up quicker, taking a starting current of about three-quarter its former value, but this starting current is not by any means a wattless current, that is, it will not affect the pressure regulation of alternators and transformers to anything like the same extent as a wattless current of the same value would do. With most types of motor above 8 H.P., especially for high frequency circuits, it becomes a matter of necessity to use a rotor resistance in order to get the motor to run up at all. What central station engineers should do is to insist upon every motor above a toy size being provided with a suitable non-inductive rotor resistance for starting, in which case the latter would not affect the system if the generating and transforming plant was suitably designed. The apparent beauty and simplicity of the squirrel cage construction and its modifications have misled people far too long. As a matter of fact its use should be given up for any single-phase motor above ½ H.P. that has to be run from *lighting* mains.

The second reason for the unpopularity of the single-phase motor is due, of course, to the large idle current when the motor is running, especially when underloaded. In the article referred to, the case is put very clearly, but the figure there given as the average power-factor of a lighting station with motors on its circuits, namely, 50 per cent., is, in the writer's opinion, somewhat too low for stations using reasonable frequencies. For distribution at 50 to 60 cycles, 65 per cent. is nearer the mark, while above these frequencies the single-phase motor becomes very nearly uncommercial from the power factor point of view. The only possible way to get better power factors is to generate and distribute at reasonable frequencies—why frequencies higher than 60 as an outside figure for any purpose are any longer tolerated is very difficult to understand. The relative advantages and disadvantages of 50—60 cycles compared with 100 cycles are so obvious that everywhere but in England the use of the higher frequency has been given up.

There is just one other point that may be profitably referred to, that is, the relative suitability of generators and transformers for running combined lighting and motor loads. With single-phase plant, unless specified otherwise (which is usually not the case), the makers supply plant whose pressure regulation is all that is asked for on a lighting load, that is, a load of power factor 95 to 100 per cent. But both with generators and transformers, the pressure drop at full load is invariably three or four times as great on a motor load as on a lighting load. The practical bearing of this upon the performance of the motor is as follows:—Suppose a transformer is taken from the stores at random to supply a single-phase motor with current. It may be quite good enough from the regulation point of view when used for lighting, but this becomes a very different thing when supplying the motor. The drop will be much greater, and as the torque of an induction motor depends very approximately upon the square of the impressed pressure, the motor is hardly able to carry its full load, let alone an overload, and, moreover, the starting will be bad. Again, a motor working below its rated voltage invariably has a lower power factor than would otherwise result. So that not only from the user's point of view, but also from that of the central station, it becomes of great importance to employ apparatus properly designed for its work. A good illustration of what the writer means is afforded by a case that recently came under his notice in London. A certain 7½-H.P. 100-cycle motor (squirrel cage rotor) was intended to be supplied from a transformer of ample size, and of quite modern and good design when used for lighting purposes, under which conditions its full load pressure drop would probably be in the region of 2—3 per cent. But on the full current being taken from it for the purpose of supplying the motor in question, the drop was found to be 12—15 per cent. The practical consequence of this was that the motor under these conditions not only had great difficulty in starting, but it would not carry even a portion of its rated load.

To sum up, when planning a single-phase supply for lighting and a proportion of power, three principal points must be borne in mind if motors are to be successfully used. They are (1) use reasonable frequencies; (2) use generators and transformers rated upon a *power* basis rather than upon a *lighting* basis; and (3) insist upon a non-inductive rotor resistance being installed with every motor.

A. C. Eborall.

London, *April 14th*, 1899.

Electrical Motor Carriages.

There seem to be so many obstacles to the ultimate firm establishment, and apparently inseparable from the early life of a new industry, such as the adverse state of the law, the over-sanguine inventor, and, lastly, the professional company promoter, that those who are most interested in the matter, and one who has largely contributed to the years of labour necessary in making the electrical vehicles a practical

success, take all these things as a matter of course. But when a gentleman of the standing of Sir David Salomons states (assuming that he has been correctly reported in the *Royal Magazine* of this month) that the electrically propelled carriage is an impossibility, it is to be pardoned if the remark is not allowed to pass unchallenged. And one is almost inclined to thing that it was made without due consideration, as was the case when the same gentleman, in estimating the cost of propulsion by electricity a year or so ago, based his calculations on the cost of electric current at 4d. per unit, whereas at that very time it was to be obtained in London at 1d. per unit.

That one does not see many self-propelled carriages on the streets here is not evidence that they are unpractical. Our natural caution in adopting new ideas, and our love of horses, are enough to account for this; although as a lover of horses myself, one of the last uses I would put a horse to would be the hauling of a tramcar or an omnibus, and I think that many of the horses one sees in cabs are fit subjects for anyone's compassion, and the sooner their use is rendered unnecessary by the introduction of electricity the better.

In spite of the long start which the automobile movement has had on the Continent, and in view of the fact that it is only during the last two years or so that one was allowed to run a motor vehicle on the streets here at all, it is a very significant fact that the principal systems of electrical vehicles which have been adopted in Paris are of English origin.

The argument which Sir David is reported to have used when discussing the "inutility" (*sic*) of electrical motors, "it is as if one should go for a fast drive and expect the horses to gallop along with a load of passengers as well as a dozen sacks of coal," is not to the point, and one is tempted to remark that the horses would go very fast indeed if they had no load at all to carry. But why Sir David should try to prove the matter by wishing to carry accumulators (represented by the sacks of coal) in a horse-drawn vehicle, I fail to understand; for when we carry a set of accumulators in our electrical vehicle, we do not want to carry a horse, but do without them.

In conclusion, I can only say that regarding the weight of an electrical carriage it is now quite possible to produce one capable of carrying two persons for a 40-mile journey, the total weight of the carriage being under 12 cwt. at a cost for electric current of two shillings (2s.) and an annual expense for renewal of accumulators of £20.

Thanking you for your courtesy in inserting this letter and apologising for taking up so much of your valuable space.

C. Oppermann.

The Automobile Club, S.W.
April 17th, 1899.

Dry Core Cable.

In the *Elektrotechnische Zeitschrift* for March 21st, 1895, a dry core cable is described in which the insulating material is a cotton gauze, the mean capacity being ·053 mfd., insulating resistance 10,000 megs. per kilometre at 15° C. Three miles of a seven-strand cable, double lead covered, and wire armoured, were laid in Cologne.

After laying, the following particulars were obtained:—

Per Km. at 15°.

No.	Ins. res. in megs.	Cap. in mfs.	Resist. in ohms.
1	8,626	053	5 98
2	9,500	054	6 12
3	9,500	·053	6·22
4	9,570	·054	6 56
5	9 570	054	6 28
6	9,850	·054	6·28
7	19,140	·053	5 99

The cable was manufactured by Frank Clouth, Cologne-Nippes.

This cable is similar to the Leno cable mentioned in Messrs. O'Gorman & Cozens-Hardy's letter in your issue of the 14th inst.

Telephone Cable Engineer.

Primary Battery Charging.

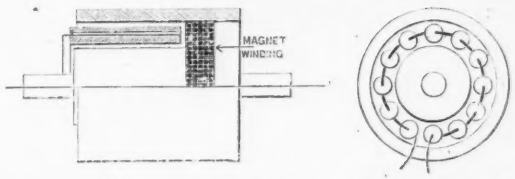
Would any of your readers give me the necessary proportions for charging a primary battery, which is of rather an obsolete type?

An iron jar with a copper top which screws down to the jar, from the bottom of the cover is suspended by a copper bar a cross of zinc. Into the jar must be put oxide of copper and a solution of caustic potash. The battery is used for working an electrical tapper for the generating of acetylene gas.

E. A. C.

Homopolar Dynamos.

The following experiments undertaken some years ago may be of interest. My original idea was, that if it were possible to protect one-half of each coil in a Mordey alternator from the magnetic effects of the rotating field magnet, then the machine would give out current unvarying in direction. The machine shown in the drawing was the outcome of this idea. The rotating magnet consisted of a bar magnet of circular section, forming one pole, while the other pole was a tube as shown in the figure. This was arranged to run in bearings. The conductors in the first case were iron tubes through which ran copper conductors, insulated, of course. These copper wires were soldered to their iron tubes at the bottom end and projected at the top end, so that they



Side view of field magnet, top part section, showing armature conductor in position. End view showing conductors connected in series.

could be soldered to the outside of the next iron tube. The idea was that a P.D. would be established between the ends of the iron armature conductors, but that the inner copper wire would be less affected by the field and form a return, as in the Gramme armature. This, of course, was not so, as might have been inferred from the behaviour of sunk conductors in ordinary armatures. A great many other experiments, in which the iron conductors were arranged to be in a strong rotating field, while the copper return leads were arranged to be in a weak part of the field, produced no results.

Working out the precise reasons why such a machine should fail would no doubt form a pretty exercise. I may say the outer pole was slit so as to ensure rotation of the field.

Charles Turnbull.

St. George's Lane, Canterbury.

Electric Piping.

As one who has had some little experience of insulated steel conduit, under the above heading, I should like to explain away, if possible, what are pointed out as some of its disadvantages.

The writer of the articles mentions that the burr caused by using the ordinary pipe-cutter in cutting is likely to extend inside the insulation.

Now, I find the best and quickest way to cut this steel conduit is by using an ordinary hand hack-saw with a Lancashire blade. Not only does it cut the tubing off square, but it leaves no burr, so that it is not necessary to trim the end with a file before screwing.

Again, in the comparison as to bending properties, anybody who has worked steel conduit, will agree with me that gas barrel is not in it. The extra small bends that can be obtained by making the gas barrel hot, are of very little service for pulling through purposes, whereas the bends and sets made in the steel conduit, while cold, are much more natural and suited to the purpose of drawing through. The bends and sets can be made (without injury to the insulation) by boring a hole a little larger than the tube to

be bent in a strong soft wood block, inserting the tube and pulling it slowly to the required angle. In the small sizes (½-inch and less) it can easily be bent over the knee. For outdoor or exposed purposes I think I was one of the first to bend insulated conduit to form brackets, making a continuous tube from the cut-out board to the lampholder.

In the comparison of sizes of insulated conduit and gas-pipe, the advantage is in favour of conduit.

In using insulated conduit we can safely use a wire of lighter insulation than for a plain metal tube. A wire of 400 meg. class taped only (with a pair in a tube) I think is quite high enough for ordinary voltages, whereas in a plain metal tube the risk of condensation alone would make it unsafe to use this wire.

In conclusion, I might point out that in my experience of over two years, working solely on insulated conduit, I have never come across a defect caused by dampness or condensation in it.

Albert B. Butt.

The Ambleside Tenders.

I beg to endorse everything that your correspondent, Mr. Beauchamp, has written in reference to forms of tender, &c. It would certainly be as well if engineers, in preparing their specifications, would give this matter their consideration. Take, for instance, the inconvenience that I was put to some few weeks back. Both my clerks were taken bad with influenza suddenly, and, owing to pressure of business, the particulars of the specification had not been copied, and as it was essential that my tender went off that day, I had to copy it out myself, thus losing an appointment which in all probability would have led to business. Of course this sort of thing would not occur with manufacturers having a large staff of clerks, but as I trade in only a comparatively small way, I find that the time spent in copying out specifications runs into a considerable amount, which I can ill afford to loose. It would be a great blessing if this defect was overcome by printing the specifications in copying ink, as your correspondent suggests. If this matter be taken up, as it should, by some of the leading manufacturers, I am sure it will prove a boon to all. Trusting you will find space for this letter in your valuable columns.

X— Secundus.

Croydon.

Wireless Telegraphy.

I should be glad if any of your readers could give me some information on the following points :—

What patent rights, if any, are held by either Signor Marconi or the Wireless Telegraph and Signal Company with respect to either the form, arrangement, or method of application, of the apparatus used by him and them in their system of wireless telegraphy, and such apparatus as was described by Signor Marconi in his lecture before the Institution of Electrical Engineers ?

Also, whether any person making use of apparatus of the same form and arrangement for the practical application of wireless telegraphy to commercial purposes, would thereby infringe any existing patents ?

Lastly, whether the Wireless Telegraph and Signal Company possess the sole right of establishing wireless telegraphy for commercial purposes ?

A. C. Nash.

Re Improved Nernst Lamp.

In your last week's edition I read of an improved form of Nernst electrolytical lamp, devised by Herr Rasch, of Nurenberg, which does not require a high temperature. As far as my information goes, this latter point is correct, but you omitted to mention that it requires a minimum voltage far in excess of what would be admissible or obtainable on any public or private electric light installation, thus excluding for all practical purposes the possibilities of having it introduced on a commercial scale.

P. H. Oppenheimer.
P. B.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the last meeting of the Institution of Electrical Engineers, held on the evening of Thursday last week, the discussion on Mrs. Ayrton's paper, "The Hissing of the Electric Arc," was concluded, and some most interesting experiments were shown by Messrs. Duddell and Marchant in describing their investigations, given in full in the paper published in the *Journal*, "Experiments on Alternate Current Arcs by Aid of Oscillographs."

After the President had announced that the annual general meeting would be held on Thursday, May 25th, 1899, Prof. Fleming resumed the discussion on Mrs. Ayrton's paper. He remarked that there are many points in connection with the arc which are only properly investigated with the aid of some preconceived theory. It was astonishing that, after the lapse of nearly a century, we should be in such a state of ignorance concerning all the phenomena of the arc. The first thing that struck one in looking at a constant current arc was the want of symmetry: the essential phenomenon consisted in the conduction of current through a column of vapour. The precise action appears to be a phenomenon similar to the electrolysis of liquids. By starting with a provisional hypothesis that the vapour is electrically broken up into two ions, that is, that the separation of the carbon vapour into two ions; the velocity of the — ion is much greater than the + ion, and we should have an accumulation of — carbon ions on the crater like a cushion, and this would have the effect that the change of potential in stepping from the + carbon to the vapour would be greater than in stepping from the vapour to the — carbon. He did not know in 1890 that in 1889 Luggin found by measuring the fall of potential between each carbon and the arc that the principal part of the diminution of pressure caused by hissing took place at the junction of the positive carbon and the arc. One knows the affinity carbon has at high temperatures for oxygen, or air. If a part of the cushion of — ions was burnt away by air getting at it a momentary greater current would ensue, causing a greater accumulation of ions. He had the curiosity to examine a hissing arc in a revolving mirror, and found that it was intermittent. This might be pictured as a rush of ions to the crater and the excavation of the crater due to the production of carbon vapour. In addition to that the theory explains the mushrooming of carbons, attributing this to the continual and very rapid delivery of ions building up the crater.

Hissing must be due to intermittency, and hissing produced by carbon at high temperature should require a gas not neutral, *i.e.*, any gas will do that has the property of combining with carbon at high temperatures. If experiments were made on this point such gases as chlorine, bromide and iodine might be tested to see if their presence would produce hissing.

He had long held the opinion that back E.M.F. in the arc did not exist, but that the apparent back E.M.F. was simply one of the factors necessary for an electrolytic process.

Captain Abney could not say that he had done anything in the field Mrs. Ayrton had so ably filled, although he had done a great deal of work on the arc. The paper was simply carried on from point to point, and reasoned out in the most admirable way; he thought everyone must come to the opinion that the conclusions were right. The hissing arc had a sad interest for him, by rule of thumb he had come to the conclusion that there was a change going on; long before Trotter's day he had been bothered by the image. He then proceeded to describe in detail certain suggested experiments that might be made with a split spectroscope and rotating sectors. He had observed a phenomenon in the arc immediately before hissing occurred that might be due to an oscillation in the arc. The phenomenon of hissing certainly was accompanied nearly always by rotation, which was excessively annoying in his experiments.

Prof. Ayrton said that Dr. Thompson had criticised the statement he had made on a previous occasion respecting the increase in current which followed the lengthening of the arc. Dr. Thompson took exception to what was said, and had observed that what should have been stated was that if you lengthen the arc you must increase the current to keep the

potential difference constant. Prof. Ayrton thought that was a distinction without a difference, and likened it to a question whether the motor is in front of a car or the car behind the motor. The same criticism might have been made out of a current through a wire, although he did not want to say that the action was the same. Suppose P.D. were taken as 55½ volts, and one arc with 4 mm. length required or took 7 amperes; on increasing the length to 5 mm. the current would be 11 amperes. On the other hand, if the conductor had been, say, a piece of lead wire, on pulling it out and increasing its length the pressure would have dropped if the P.D. were not to alter.

He would break a lance upon what Captain Abney had referred to—the slow rotation of bands seen on the carbons before the arc hisses, or hums even. Dr. Thompson had said that he thought this had been pointed out by Trotter. On looking over the Royal Society paper and article in the *Electrician* he had been unable to find any reference whatever. Here Dr. Thompson referred Prof. Ayrton to his "Cantor Lectures" at the Society of Arts.

Mr. Trotter invited Prof. Ayrton to see the rapid rotation of the "comma" in his laboratory. The speaker had no recollection whatever of the slow rotation of dark bands which could be seen without rotating sectors at all. He did not know that Dr. Thompson had grasped that the region of instability was quite altered in different arcs. The length of arc was not altered. The region of mental and electrical blankness in which he was floundering was cleared by Mrs. Ayrton's explanation that the arc was ready to tumble down one of the inclined planes shown on the curves, but which one depended entirely on the outside resistance of the circuit, whether down a line shown or a steeper line.

"Life is short and arcs are long." He would not allow himself to delay the meeting by talking of the methods used in carrying out the experiments in the paper. One of the peculiarities Mrs. Ayrton adopts is the method of studying the known by searching among the unknown. Of books, as she herself said, she is profoundly ignorant, but more can be learnt by careful examination than otherwise.

Mrs. Ayrton, in replying to the discussion upon her paper, expressed her gratitude for the appreciation granted to what she modestly termed "the very small amount of scientific work" it contained. The arc makes a great many noises, and noise is one important part of the hissing arc, the interesting part was best shown by the blank region on the curves. Mr. Mordey asked if hissing arcs gave out less light than silent ones. The author had made no experiments, but Blondel in 1893 found that hissing arcs gave 10 per cent. to 20 per cent. less light than normal, although the power supplied also falls. No experiments had been made on alternating arcs. The enclosed arc used in these experiments was not what was commercially known as an "enclosed arc," and the differing shapes of the carbons was due to this fact. Blondel in 1893 had noticed the green flame in the arc; he had done more good work on the arc than any other single individual. He had suggested that a hissing arc was disruptive. Mrs. Ayrton briefly dealt with Prof. Fleming's suggestion as to carbon ions, and closed by again thanking the members for the way her paper had been received.

The president (Mr. J. W. Swan) remarked that Mrs. Ayrton was not a member of the Institution, but he did not know of any legal disability debarring ladies from becoming members.

Messrs. Duddell and Marchant followed with the beautiful experiments illustrating their paper, and the discussion was taken up briefly by Mr. Leonard Andrews and Prof. Ayrton. As the discussion was adjourned at the suggestion of Mr. Mordey, we shall give the remarks with those of other speakers.

Motors on Public Supply Circuits.—The one thing necessary to develop motor business on public supply mains is to supply electricity at something like 1d. or 1½d. per unit. The Cork system has not been in existence more than six months, yet the aggregate horse-power of motors connected to the mains is over 200 H.P., which shows in a striking manner the advantages accruing to low charges.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week ending Mar. 29th, 1898.

		Value	£
Alexandria	..	..	426
Amsterdam	..	..	200
Bangkok	..	..	467
Bilbao	..	..	88
„ Teleg. mat.	..	..	790
Boca	..	..	77
Buenos Ayres	..	..	265
„ Teleg. mat.	..	..	100
Calcutta	..	..	196
Cape Town	..	..	1,437
Colombo	..	..	848
Durban	..	..	1,707
„ Teleg mat.	..	..	1,097
East London	..	..	513
Flushing	..	..	8
Gibraltar. Elec. cable	..	..	700
Gothenburg	..	..	133
Hamburg	..	..	10
Hong Kong	..	..	14
Launceston	..	..	14
Madras	..	..	218
Malta	..	..	54
Natal	..	..	78
„ Teleg. mat.	..	..	1,945
Passages	..	..	107
Perth	..	..	200
Port Elizabeth	..	..	31
Port Said	..	..	13
Rangoon	..	..	345
Rio de Janeiro	..	..	20
Rosario. Teleg. mat.	..	..	60
Santos	..	..	26
Seville	..	..	100
Shanghai	..	..	271
„ Teleg. mat.	..	..	350
Singapore. Teleg. mat.	..	..	45
Spezzia	..	..	650
St. John's, N.B.	..	..	10
Stockholm. Teleg. mat.	..	..	172
Sydney	..	..	441
Tientsin	..	..	85
Wellington	..	..	85
Yokohama	..	..	585
Total	..	..	£14,881

Week ending Mar. 28th, 1899.

		Value	£
Adelaide	..	..	375
„ Teleph. mat.	..	..	1,250
Amsterdam	..	..	70
Auckland	..	..	379
Bangkok	..	..	883
Bilbao	..	..	30
Bombay	..	..	43
Boulogne	..	..	95
Calcutta	..	..	98
Cape Town	..	..	73
Colombo	..	..	182
Copenhagen	..	..	53
Durban	..	..	407
East London	..	..	526
Fremantle	..	..	272
Gibraltar	..	..	250
Gothenburg	..	..	105
Hobart	..	..	95
Hong Kong	..	..	30
Malta	..	..	28
Melbourne	..	..	167
Piræus	..	..	71
Port Elizabeth	..	..	96
Rio Janeiro	..	..	50
„ Teleg. mat.	..	..	128
Rotterdam. Teleg. mat.	..	..	25
St. Petersburg. Teleg. mat.	..	..	128
Stockholm. Teleg. mat.	..	..	209
Sydney	..	..	1,130
„ Teleg. mat.	..	..	192
Toronto	..	..	92
Wellington	..	..	225
Total	..	..	£7,247

Foreign Goods Transhipped.

Monte Video. Teleph. mat.	..	..	£9
Sydney. Teleph. mat.	..	..	74
Total	..	..	£83

Electrical Wares Exported.

Week ending April 5th, 1898.

		Value	£
Adelaide	..	..	334
Alexandria. Telep. mat.	..	..	16
Amsterdam	..	..	60
Barcelona	..	..	41
Bombay	..	..	333
Boulogne	..	..	84
Calcutta	..	..	329
Cape Town	..	..	139
Colombo	..	..	51
East London	..	..	51
Flushing	..	..	36
Genoa	..	..	500
Gibraltar	..	..	199
Malaga	..	..	196
Madeira	..	..	40
Melbourne	..	..	135
„ Teleg. mat.	..	..	500
Odessa	..	..	90
Port Elizabeth	..	..	670
Reval	..	..	315
Rio Janeiro	..	..	63
Stockholm. Teleph. mat.	..	..	100
Sydney	..	..	347
Trieste. Teleg. mat.	..	..	400
Trinidad	..	..	16
Yokohama	..	..	225
Total	..	..	£6,870

Week ending April 4th, 1899.

		Value	£
Alexandria	..	..	64
Amsterdam	..	..	90
Bangkok	..	..	29
Buenos Ayres	..	..	35
„ Teleg. mat.	..	..	190
Calcutta	..	..	11
Cape Town	..	..	44
Chinde	..	..	13
Colombo	..	..	284
Delagoa Bay	..	..	5
Demerara	..	..	24
Durban	..	..	21
„ Teleg. mat.	..	..	28
Genoa	..	..	285
Hong Kong	..	..	1,020
Labuan. Teleg. mat.	..	..	42
Launceston	..	..	186
Madras	..	..	10
Melbourne	..	..	170
Monte Video	..	..	70
Otago	..	..	7
Reval	..	..	24
Rio de Janeiro	..	..	79
Rosario	..	..	9
St. Petersburg	..	..	55
„ Teleg. mat.	..	..	125
Sydney	..	..	102
Valparaiso	..	..	100
Wellington	..	..	234
Yokohama	..	..	96
Total	..	..	£3,452

Foreign Goods Transhipped.

Oporto	..	..	£191
Total	..	..	£191

Durban. Elec. mat.	..	..	£20
New York. Elec. machinery	..	..	105
Total	..	..	£125

Acme Circulators.—The Steam Boilers Circulators Company, Limited, Manchester, have issued a small pamphlet in which by means of illustrations and brief letterpress explanation they give a very clear description of their circulator in its adaptation to the cross water-tubes of Lancashire and Cornish boilers for the more rapid raising of steam. A note is included of a recent test made on two Cornish boilers, 24 feet × 6 feet 6 inches, situated side by side and identical in every respect save that one had the Acme circulators and the other had not. The circulatorless boiler commenced to blow off steam at 60 lbs. pressure in 5 hours 40 minutes from the lighting of the fires, and the other with nine circulators fitted, in 4 hours 40 minutes. This represents a saving of 18 per cent. in time. Evaporative tests taken at various intervals during a whole month confirmed these results. There is also, of course, a very appreciable saving in fuel.

Bankruptcy Proceedings.—At a sitting of the London Bankruptcy Court held last Friday before Mr. Registrar Brougham, Edward Baldwin Pym, electrical engineer, formerly of Bar Chambers, Scarborough, next of Bramwell Gardens, South Kensington, and now of Burnham, attended for public examination upon accounts showing liabilities £3,744, and assets *nil*. In the course of his evidence the debtor said he had been entitled, under the will of his uncle, to a life interest in £10,000, but that had been terminated by the bankruptcy proceedings. He only owed about £130 in respect of the electrical business, and a sum of £1,800 owing to his brother-in-law was to be paid by his wife when she succeeded to some property to which she was entitled. His business at Scarborough was not successful, and he had been concerned in various bill transactions. The examination was concluded.

A statement has been issued by the Official Receiver for Huddersfield (Mr. J. Arthur Binns) to the creditors of James E. Stott & Co., trading as electricians at 10, Wood Street, and Byrom Arcade, Huddersfield. The gross liabilities are estimated at £731, and the assets, after the payment of preferential claims, at £274, having a deficiency of £323. The debtor attributes his failure to losses on contracts and on the manufacture of electrical fittings.

The first meeting in *re* J. E. Stott, electrician (J. E. Stott & Co., Huddersfield), will be held on April 24th, at 12 noon, at the Official Receiver's chambers, 19, John William Street, and the public examination on April 28th, at 2 p.m., at the County Court, Huddersfield.

Books Received.—"Inwood's Tables for the Purchasing of Estates, &c.," by W. Schooling. Crosby Lockwood & Son, London. 8s. net.

"The Electrical Transmission of Energy." A manual for the design of electrical circuits, by A. V. Abbott. Second edition. London: Sampson, Low, Marston & Co.

Car Fatality.—A dock labourer was killed through being knocked down by an electric car in St. James's Street, Liverpool, on 6th inst. The jury attributed no blame to anyone.

Carbide Manufacture in Bosnia.—What is claimed to be the largest calcium carbide factory in Europe has just been started at Jajce, Bosnia, by the Bosnian Electrical Company, of Vienna. Water power is utilised. The existing electrical plant, which has been supplied by Messrs. Schuckert & Co., of Nurembourg, has a capacity of 2,000 H.P., and it is shortly to be increased to 8,000 H.P.

Catalogue.—Messrs. W. J. Edwards & Co., of Birmingham (who have just removed their London office and warehouse from 31, Holborn Viaduct, to 59–61, Hatton Garden, E.C.), send us a copy of their new catalogue of electric light fittings. It contains a number of designs, some of which are very pleasing, of electroliers, brackets, standards, pendants, and other electric light fittings which they make in brass, copper, bronze, and wrought-iron.

Charge of Forgery.—At the Mansion House before the Lord Mayor last Saturday a young labourer named Creighton was remanded on a charge of attempting to obtain, by means of a forged order purporting to be signed by Mr. Leo Sunderland, the agent to the Brush Electrical Engineering Company, Limited, 33, Victoria Street, Westminster, four coils of wire and one coil of cable to the value of £10; and further with obtaining, on the 11th inst., four coils of cable to the value of £9 9s. 8d., and on the 12th inst. two coils of cable and four coils of wire, worth £9 1s. 8d., the property of the India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited, 106, Cannon Street, by means of similar forgeries.

Correction.—Messrs. O'Gorman & Cozens-Hardy ask us to say that they are not connected in any way with any manufacturing firm. Through a misunderstanding they allowed their name to appear in the current issue of the Directory in such a way as to convey this impression.

Electric Pumping.—An electric pump has been fixed at the South Rhondda Colliery, in South Glamorgan, at a distance of 900 yards from the bottom of one of the shafts. It is worked by means of a generator on the surface and throws the water to a spot 500 yards distant.

Free Wiring.—The Corporation of Tunbridge Wells having entered into a contract for free wiring with the National Electric Free Wiring Company, Limited, of Faraday House, Charing Cross Road, London, W.C., this company has opened temporary premises at Bedford House, Mount Zion, during the building of a permanent showroom. Several installation orders are already in hand, including motors for printing works, &c. The Salisbury Electric Light Company have also entered into a contract with the National Electric Free Wiring Company, Limited, and the latter company has commenced operations, the temporary address being Town Mill, Salisbury. A similar contract for free wiring at Northampton has been sealed between the Supply Company and the National Electric Free Wiring Company, Limited, whose temporary address is care of the Electricity Works, Angel Lane, Northampton.

Fuel Economisers.—We understand that the largest single order for fuel economisers that has ever been placed, has recently been given out by the East End Electric Railway Company for the new power station at New York, United States of America. Keen competition existed amongst the various makers, but in the end the well-known Green's improved modern economiser was selected. This is an important order and amounts to about 10,000 tubes.

A German Company.—Messrs. Garbe, Lahmeyer & Co., of Aachen, have reconstructed their business and formed it into a limited liability company with a capital of 3,000,000 marks. The directors will be Herr Heinrich Garbe, and Herr Clemens Adam, the former chief engineer; and Herr Max Muller will act as adviser to the company. The managers of the company will be Herren Commerzienrat Gustav Talbot, Carl Springsfield, and Arthur Pastor. The company is now known as "Deutsche Elektrizitäts—Werke Zu Aachen—Garbe, Lahmeyer & Co."

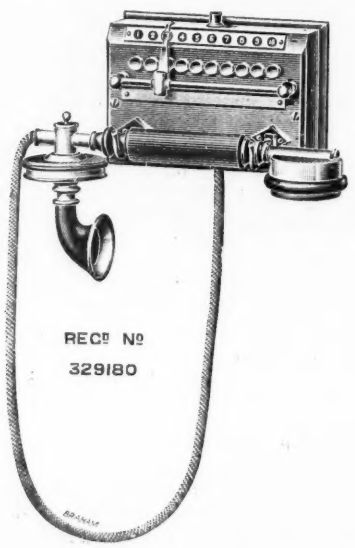
Liquidations, Dissolutions, and Other Notices.—The Coventry Electric Tramways, Limited, will meet at 17, Hertford Street, Coventry, on May 17th, to hear an account of the liquidation proceedings from the liquidator, Mr. E. T. Peirson.

Messrs. A. W. Jackson and F. J. Coleby (Jackson & Coleby, electrical engineers, Thayer Street, Manchester Square, London) have dissolved partnership. Mr. Coleby will carry on the business and attend to debts, &c.

Messrs. F. & A. H. Hodgson (F. Hodgson & Co., electrical engineers, 56, Gresham Street, E.C.) have dissolved partnership.

A New German Accumulator Company.—The Minerva Accumulatoren-Fabrik Gesellschaft is the title of a company which has just been formed in Berlin with a capital of £5,000.

Private Telephones.—Although the telephone is becoming increasingly regarded as an indispensable feature of commercial life, and its application as reflected in the reports of the National Telephone Company is growing by leaps and bounds, there is reason to hope that the future extensions will far outshine the past advances. Not only will advances be made in exchange lines, but it is believed that there is very considerable room for development in the direction of private telephone installations. There are thousands upon thousands of warehouses in this country we imagine, which have no up-to-date method of communicating from department to department or from room to room, and it is sometimes hinted that the trade does not push the business thoroughly and bring it before the attention of likely users. Those who have tried proper methods appreciate the advantages which they carry in their train, and they would not care to relinquish their use. Various firms have for many years been doing their best to improve private telephone apparatus, and have thus brought it to the high degree of perfection which characterises it to-day, when the fitting-up is properly done. Among the more recent inventions in this field is the "Handcom" intercommunication telephone of the General Electric Company, Limited, for which is claimed its all-round adaptability to any condition of fixing that may arise. As regards neatness of appearance and finish, we should think the apparatus, a specimen of which is before us, good enough for any office, however palatial in its furnishings. From our illustration it will be seen that the instrument can be fitted to almost any position, this being largely due to the fact that the automatic switch hook of the ordinary form of telephone is entirely dispensed with, so that the hand combination can be suspended or laid down in any position that may be convenient. The switching arrangement for disconnecting the bell and closing the telephone and microphone circuits is contained in the handle of the hand combination, and takes the form of a lever which has to be kept pressed whilst using the instrument. Inside the containing case is the induction coil, call buzzer, and the necessary connecting terminals. The number labels are arranged so that they can be adjusted to read in any direction according to the position in which the instrument is fixed. As the wires leading into the instrument may come from any direction, it is not possible to make a hard and fast provision for their entrance to the interior of the instrument. Provision is therefore made for an entrance on each side and one at the bottom of the case. These entrances are closed by a small nickelled plate, and all that is necessary is to remove the plate from the side at which it is required to enter. The "Handcom" set can be used in connection with any of the "General" intercommunication instruments. It is made for wall, desk and other use.



Removals.—It is stated that Mr. Norman H. Edmondson, electrical engineer, has just removed from Queen Street to Market Street, Morecambe, having "bought out" the sheriff and stopped the sale announced on his premises for April 10th.

Mr. James Wilson, electrical engineer, &c., has just removed from 147, St. John's Hill, Battersea, S.W., to Ferrier Works, North Street, Wandsworth, S.W.

Messrs. Sax, Slatter & Co., Limited, of 1, Basil Street, Sloane Street, S.W., notify that on and after April 8th all communications should be addressed to Foresters' Hall, Clerkenwell, E.C.

Rise in German Electrical Prices.—The Berlin correspondent of the *Financial News* says that the German Electricity Works are announcing, through the medium of a circular, that in consequence of the higher prices of raw materials they have decided to increase by 5 per cent. the prices of various electric products. The circular is signed by the seven most important works in Germany, viz., Messrs. Siemens & Halske; the General Electricity Company, at Berlin; Schuckert & Co., at Nuremberg; the Helios firm, at Cologne; Kummer, at Dresden; and Lahmeyer & Co., at Frankfort. Only a few smaller concerns have not yet made known their decision. Their adhesion to the "ring," however, is very probable.

St. James's and Pall Mall Electric Light Company.—The amount of electricity sold by the company for the quarter ended March 25th is returned at 1,161,987 units, estimated to produce £21,061, as against 1,016,642 units, which produced £20,036, for the corresponding period of last year. A further reduction of charges was made from January 1st last.

Theft.—On the 15th inst. Mr. Loveland Loveland, Q.C., sitting at Newington, sentenced W. Clark, J. Williams, and J. Smith to twelve, eight, and four months' hard labour respectively for having stolen a quantity of electric light cable, the property of the Crystal Palace Electric Supply Company. Two others named Gunning and Rodd were acquitted.

The Wehnelt Interrupter.—On 12th inst. at a meeting of the Hunterian Society at the London Institute, Finsbury Circus, Messrs. Harry W. Cox, Limited, exhibited the above interrupter working with one of their 14-inch spark coils. The tube used was a Cox Record. There were 24 2-volt accumulators employed, and no resistance was used. The tube worked with perfect steadiness the whole of the evening and the interrupter was almost noiseless. It was pronounced a great success, and proved beyond a doubt that it is possible to use this interrupter for long runs with the ordinary tubes. The current taken was from 5 to 6 amperes. A number of interesting examinations were made.

Wire Rope Preservation.—We have received from the Hartlepool Ropery Company a pamphlet on their wire rope preserving compound named Glissautoline. This composition is claimed not only as a preservative but as a lubricant, and an experiment by Mr. Biggart is quoted which showed that while an unlubricated rope stood 16,000 bendings before fracture commenced, a rope constructed on the lubrication principle stood 38,000 bends over the same pulley. In making this wire rope the cores and the wires are thoroughly coated with the compound. A sample immersed 12 weeks in a solution of brine—one salt to three of water—was unaffected. Other samples were all unaffected after immersion of 10 weeks in exhaust steam; 10 weeks in water at 140°; 22 days in strong solution of sulphuric acid; the same period in the solution at 280° F.; 12 weeks in sea water; 17 weeks in the open air; and 12 weeks just buried in earth and exposed to moisture from a hot water overflow at 140°. Two weeks in strong ammonia solution also left no effects. It is also claimed that a rope can be recoated should the material in time be worn off or absorbed by dust.

ELECTRIC LIGHTING NOTES.

Ambleside.—At last week's meeting of the Council the Electric Light Committee reported that Mr. Charles Hopkinson had considered tenders for the electric light installation. The total amount of the tenders recommended by him as most favourable was £3,111. This sum provided for a large development of the number of lights before the machinery and mains would be overloaded. The committee recommended that application be made to the Local Government Board for authority to borrow £4,000, to provide for the £3,111, buildings, professional charges and extension of mains. Negotiations with the Windermere Company had been progressing for a supply in bulk, but after discussing the figures with Mr. Hopkinson the committee decided that the offer made by them would not be to the advantage of the Council to accept. Mr. Hopkinson then addressed the Council, saying that after the death of his elder brother he had been instructed to work out the details of the scheme, and he found it would be distinctly advantageous to the Council to adopt the continuous system and gave his reasons for arriving at this conclusion. The tenders he had got in were more favourable than he had expected, and there were 24 in number, and he named the ones recommended for acceptance. He estimated the total capital required at £3,800, which would include the contracts for the three departments of work. Calculating the loan at 3 per cent. for 30 years would make it £194 per annum, labour £130, gas £100, repairs, renewals and depreciation £150, making a total of £574. The Windermere Electric Supply Company had offered to supply the bulk, giving two terminal wires going into a meter, and giving a current at 2,000 volts. They offered it now at 3½d. per unit, though their original price was 4d. Taking it at the lower figure it would come to £593, as against £574 for the Council to supply their own. A long discussion followed, and it was ultimately decided to adjourn the matter for a fortnight.

Alderley Edge.—New works are now being erected on land at Belmont, near Alderley Edge, for the Alderley Edge Electric Supply Company. It is hoped that the village will be lighted during the coming summer.

Ashton.—The Corporation hopes to be in a position to supply current in a few days.

Asylum Lighting.—The governors of the Richmond (Dublin) District Lunatic Asylum are protesting against the action of the Board of Control in accepting the tender of a Belfast firm for the supply of electric light to Portrane, inasmuch as the Board of Governors, although responsible for the management of the Asylum, have not had any opportunity of examining or reporting upon any such tender, and they request the Board of Control to submit those tenders to the Board of Governors.

Barnsley.—Mr. S. E. Bastow, of Hull, has been appointed clerk of works in connection with the construction of the electric lighting plant, and to afterwards run the plant. The mains are now being laid.

Beckenham.—The British Insulated Wire Company has submitted names of bondsmen to give security for the proper carrying out of the electric lighting contract. The Board of Trade has sanctioned the proposed system of electrical supply.

Belfast.—The engineer's summary of the electric light rental for quarter ending March 31st, shows that the quantity of current consumed was more than double that of the corresponding period of last year, and that the average price for lighting was 5½d. per unit against 6½d. in the corresponding quarter of last year.

Bermondsey.—At a meeting of the Vestry on Monday Mr. Cox, chairman of the Electric Lighting Committee, reported that the first reading had already taken place of the Bill to confirm the provisional order granted by the Board of Trade, and that the Bill had been referred to the examiners of petitions for private Bills. The Committee stated that in the event of the Bill being read a second time and opposed in Committee, it would be necessary to brief counsel to support the Vestry's case, and they had instructed the clerk to retain counsel for that purpose. Commenting upon the position, Mr. Cox remarked that they were two months in advance of last year, so that the Vestry stood a better chance of getting the Bill passed than last year. It was decided to approve the action of the Committee. The Electric Lighting Committee further reported that the Board of Trade have made an award in the appeal of the London Electric Supply Corporation against the disapproval by the Vestry of the laying of mains on both sides of several streets. The award is as follows:—"(1) That mains are to be laid on one side of the street only, except in Bermondsey New Road, between Grange Road and the boundary of the parish of Bermondsey; (2) That where the undertakers have already laid trunk mains the new mains shall be, as far as possible, laid under or over the trunk mains; (3) That in case the undertakers require hereafter to lay a main on the other side of any street to that in which they may have laid mains under this decision for the purpose of supply to one or more consumers, they shall serve a notice and plan upon the Vestry, as required by Section 14 of the order of 1889." Commenting upon this decision, the Electric Lighting Committee stated that, with the exception of Bermondsey New Road, they had been successful in preventing the company from laying mains on both sides of the streets. The London Electric Supply Corporation had given notice of intention to construct transformer boxes in certain streets. It was decided to approve the works subject to the covers of all boxes at the street level being "constructed of the Patent Safety Tread Company's patent material in lieu of the concrete covers fixed in two cases."

Birkenhead.—The chairman of the Watch Committee said last week that it was not intended to extend the street electric lighting at present owing to the expense. The Parliamentary Committee is considering the Government telephone proposals.

Bootle.—Yesterday evening (20th inst.) the public inauguration of the municipal electricity works took place. The party subsequently dined at the Town Hall by invitation of the Mayor (Councillor W. R. Brewster).

Bradford.—At last week's meeting of the Gas and Electricity Supply Committees, a discussion arose on the charges to consumers for electricity chiefly for motive power purposes, and Mr. A. H. Gibbings, the electrical engineer, is to report upon the matter. It is suggested that a tender amounting to £3,000 be accepted for new batteries at the old works.

Bridgend.—The English Industrials Company, Limited, has offered to take over the provisional order for the district and pay the Council 5 per cent. of the annual net profits of the undertaking. The company offers to lay mains over the whole of the compulsory area within 18 months of the date of the transfer. The Finance Committee is considering the matter.

Bristol.—The Electrical Committee has been again going into the question of main extensions, and has decided to lay mains for the lighting of a portion of Rupert Street, and on to Horfield, also from Chantry Road to Hurle Crescent.

Cardiff.—Messrs. S. F. Walker & Co. are asking for a supply of 4,500 units per annum for motive power purposes if they can get it at 2d. per unit. Mr. Applebee says that the charge is at

present 2½d., but he suggests that when the quantity exceeds 4,000 units the charge should be 2d. The firm guarantees a revenue of £37 10s. per annum, and to lay the mains down Severn Road will cost £20. The matter is being further considered by Mr. Applebee.

To lay mains necessary for lighting the new Presbyterian Church at Roath Park, Cardiff, will cost £875. Mr. Applebee advises that if the mains are extended the streets traversed should be lighted electrically and the residents canvassed.

Calcutta.—Messrs. Crompton & Co. have received a cablegram from Calcutta, stating that the supply of electrical energy for lighting and power has been commenced in that city. This is said to be the first occasion of the supply of electricity from a central generating station in India.

Chatham.—The Council has decided to ask a number of firms to tender for the wiring and fitting of the Town Hall for electric lighting.

Cheddar.—It is stated that a Westminster electrical engineer has been corresponding with a prominent resident as to the cost, &c., of lighting the village electrically.

Cheltenham.—The official inauguration of the electric lighting of the Corn Exchange took place on 11th inst. There are a number of clusters of three 150-C.P. lamps from the roof surmounted by large reflectors, and a number of brackets and other fittings with lamps of various C.P's.

China.—The *China Telegraph* understands that the tender for the additional electric lighting of the Chinese Bund has been let to the Oriental Electric and General Import Company. American machinery and appliances will be utilised. The same firm has also received contracts of considerable magnitude for similar work from Messrs. Carlowitz & Co. (Hankow), the Sun Dah Cotton Mill (Tungchow), besides general lighting at Port Arthur.

Darfield.—At the last Council meeting the clerk reported that as a result of the public inquiry held a short time ago respecting the Council applying for power to supply the township with electric light, the Local Government Board had decided not to proceed any further with the inquiry, in consequence of the heavy cost of the proposed plant and maintenance.

Devonport.—The Council last week confirmed the appointment of Mr. Furness as resident electrical engineer. It has been resolved to proceed with the lighting of all the main roads in the outer wards by electricity forthwith. The capital outlay will be £7,000, and this will form the nucleus, so to speak, of the general electric lighting scheme. Mr. Furness will bring up a report on the matter.

Dollar.—The Burgh Commissioners on Monday considered a letter from Mr. W. T. Purves, of Edinburgh, asking to be allowed to submit an electric light scheme. The Commissioners decided to favourably consider any scheme.

Dorking.—The Finance Committee has considered Mr. Trentham's report on electric lighting in which he says that electric lighting could not pay at Dorking in the first year, but it might in the second and certainly would in the third if the undertaking were carefully designed and managed. He recommends a site in Station Road. The estimated cost of the scheme is put at £19,833. The matter came before the Council last week and was deferred for two months.

Douglas (I.O.M.).—The Town Council on 12th inst. decided, by 14 votes to 5, to establish an electrical undertaking on the lines suggested in Prof. Fleming's report. A special committee was appointed to report to the Council in due course.

Dublin.—The application of the Dublin Corporation to Parliament for a Bill to greatly enlarge its boundaries has forced upon the Corporation the idea of the absolute necessity of dealing with the electric lighting of the city on a more comprehensive basis than hitherto. The site in Fleet Street, at the back of the Bank of Ireland, is so cramped, that extensions there cannot take place, and it has more than once been suggested that an admirable site was available for new works at the Pigeon House Fort, which, though some 3 or 4 miles from the centre of the city, combines the immense advantage of absolute freedom from nuisance, coals delivered by ship into the bunkers, and the Irish Sea for the condensing pond. Anxious to place themselves in a position to convince Parliament that they were in earnest, the committee applied to Prof. Kennedy to lay a scheme before them; but when the representatives of the committee interviewed the Professor, he had taken his ticket for New York, and failing Prof. Kennedy, the work has now been entrusted to Mr. Robert Hammond, who already has two important electrical undertakings in hand in the immediate neighbourhood of Dublin, curiously enough within the area which the Dublin Corporation is seeking to annex, viz., Rathmines and Pembroke. It is expected that the initial outlay upon the new site, with the mains extension that follows in its wake, will be £100,000.

Dudley.—The wiring and lighting of the Corporation supply station for tramways and lighting is being carried out by Messrs. Whittaker Bros. The plant for running the tramway system is nearly completed.

Dunblane.—The convener of the Lighting Committee has reported that his committee have had a joint meeting with Bridge of Allan Commissioners with a view to both places joining for a supply of electric light. It was said that it would not pay either of the two places to provide an installation, but, joining together, the Edmundson Company is willing to take the project in hand.

Ecclesall.—The Guardians having considered the scheme for electrically lighting the new hospitals and the workhouse premises, have decided that they cannot adopt it at present in view of the increased cost compared with gas.

Edinburgh.—The Council has remitted to the Electric Lighting Committee to report as to the charge to be made for electrical energy for the year 1899-1900.

Electric Light and Harbour Defences.—In the House of Commons on Monday, in reply to Colonel Kenyon-Slaney, Mr. Powell-Williams said the electric light service in each section of a fortress is under the section commander, through the officer in charge of submarine mining defences, who is a Royal Engineer. The fire commander is under a Royal Artillery officer, who is also under the immediate orders of the section commander. The general officers commanding are responsible for the efficiency of their harbour defences, and there is no reason for supposing that they are dissatisfied with the electric light service.

Enniskillen.—The Council has asked a local firm to furnish estimates for the lighting of the new Town Hall by gas and electricity.

Falkirk.—In relegating the consideration of the question of new gas works to the gas engineer and manager, the Gas Commissioners have instructed them to bear in mind the possibility of the introduction of the electric light. In the course of a discussion one speaker who had conferred with an electrical engineer suggested putting down turbines at the water works for driving the electric generators.

Felixstowe.—A Stowmarket firm is said to be negotiating for the purchase of land for the erection of an electric lighting station.

Fulham.—The tenders submitted to Mr. Medhurst's specification for electrical plant, &c., came before the Vestry on Wednesday. They are as follows:—

The General Electric Company, Limited	£45,718 7 10
The Brush Electrical Engineering Company, Limited	47,282 0 0
Messrs. Ferranti, Limited	49,339 17 2
Messrs. Johnson & Phillips	49,927 6 0
Messrs. John Fowler & Co., Limited	50,815 2 6
The British Insulated Wire Company, Limited	51,524 8 6

Garston.—At the District Council meeting on 17th inst. the legal adviser reported that the Garston District Electric Lighting Company had agreed to the insertion of the clause in the agreement providing that the company should bear the full costs of applying for the sanction of the Board of Trade to the transfer of the Council's electric lighting order to them, whether granted or not. A letter was read from the Liverpool District Lighting Company offering to take over the work. Several members having remarked that the terms of the Liverpool District Company were too high, the agreement with the Garston Company (Messrs. Atherton & Nesbit) was approved.

Grimsby.—The Local Government Board inquiry having been held, the Council has authorised the Public Lighting Committee to invite tenders for the building of electric lighting plant and for machinery.

Heckmondwike.—The Electric Lighting Committee has agreed upon its report, which is unanimously in favour of the adoption of an electric lighting scheme for the town, in accordance with plans prepared by Mr. Hawtayne.

Hendon.—It is stated that as a result of the Board of Trade inquiry, an arrangement has been arrived at for the assignment of the provisional order to the Electrical and General Engineering Company as soon as granted to the Council.

Hornsey.—The District Council on Monday referred to a special committee the question of bringing up a full report as to the provision of a central station for the generation of electrical energy, the cost of the necessary buildings, machinery, equipment, distributing and feeder mains, &c., with power to obtain expert advice. The Council already have a provisional order, and the chairman expressed his intention of opposing the scheme at every stage. The Council have refused a number of offers to take over the order.

Ilford.—The Council, through committee, is arranging for the purchase of land in Ley Street for electric light station, tramways depôt, &c. Mr. Hawtayne's supplemental report on electric lighting has been adopted, and he is now getting out specifications for inviting tenders. Application is being made to the Local Government Board *re* loan.

Islington.—The Vestry have decided to acquire certain property in Newington Green Road for the purpose of a sub-transformer station. The Electric Lighting Committee reported at the last meeting that Messrs. Johnson & Phillips had discovered an error in their tender for the supply of carbons, and that they were therefore unable to complete the contract for that article. On the recommendation of the committee it was decided to accept the tender of Mr. Oscar Scholzig, 8, New Broad Street, E.C., for carbons in lieu of the other firm. The committee recommend the Vestry to increase the salary of Mr. C. H. Yeaman, assistant electrical engineer, from £200 to £250 per annum, and by two further annual increments of £25 each.

Keighley.—The Council has decided upon the Low Bridge site for electricity works, and an electrical engineer is to be engaged to prepare plans and estimates and to superintend the laying down and running of the undertaking.

(*Continued on page* 647.)

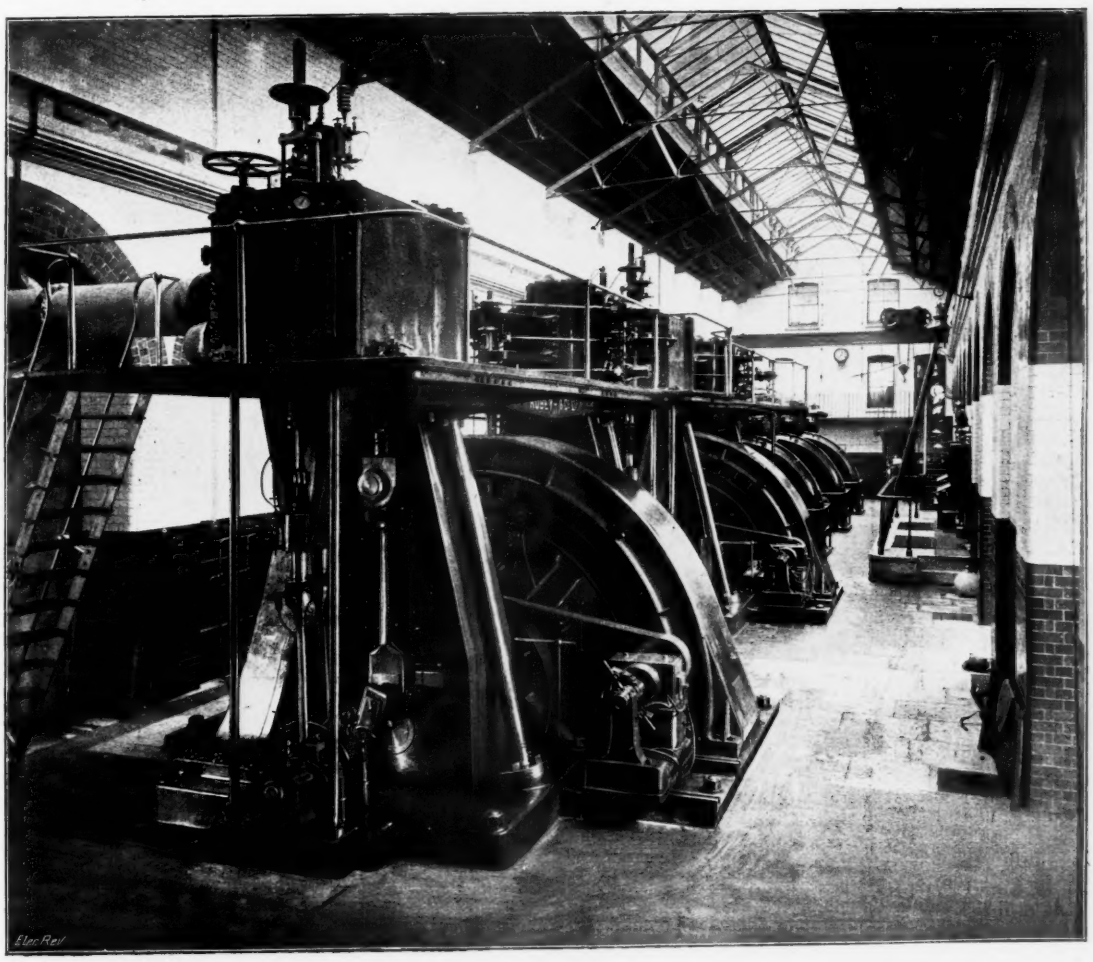
HAMMERSMITH ELECTRICITY WORKS EXTENSIONS.

The electricity works of the Hammersmith Vestry, which were opened in November, 1897, have now been extended, and already the capacity is more than doubled. The station commenced running with three sets of 125 kw. each and a small 25 kw. day-load plant, but owing to increasing demand it soon became necessary to arrange for additional machines.

Most electrical manufacturers have of late been experiencing considerable difficulty in turning out work with desirable rapidity, owing to the large number of orders in hand and also owing to the arrears left to be worked off after the termination of the engineers' strike. It is therefore not surprising that before the contractors were ready to lay down the extension sets the original Hammersmith machines were heavily overloaded every night, latterly to the extent of 30 or 40 per cent.

The site of the Hammersmith supply works is splendidly situated for extensions, there being something like seven acres available. The outlook for electricity supply business is so promising, that Mr. G. G. Bell, the engineer and manager of the works, is confident that before many years have flown the greater portion of this land will be occupied in some way or other for the purposes of the undertaking. There is no likelihood of the Hammersmith Vestry finding itself in the predicament of some other undertakers who find it necessary either to apply for Parliamentary powers for compulsory purchase of sites upon which to extend their works, or to erect a second station. The extension just carried out consists of an enlargement of the engine room by 66 feet × 27 feet, where two new E.C.C.-Robey 300-kw. steam alternators are now in position. Space is also left for a third set of like capacity with Ferranti alternator and Robey engine now on order.

We show in one of our illustrations an interior view of the station, in its extended state, with the three 125-kw. Ferranti-McLaren steam alternators in the distance, the two new machines appearing in the foreground. These two



General View.

300-kw. sets nightly run away with the whole of the load, the maximum being 550 kw. The old machines are kept in reserve. The three rectifiers for the purpose of street arc lighting originally stood in the main station, but these have now, for the sake of convenience, been placed in a special off-room to the right, and two new rectifiers which differ somewhat from the original machines as will be seen later, have been introduced to meet the extended street lighting which was inaugurated on March 27th.

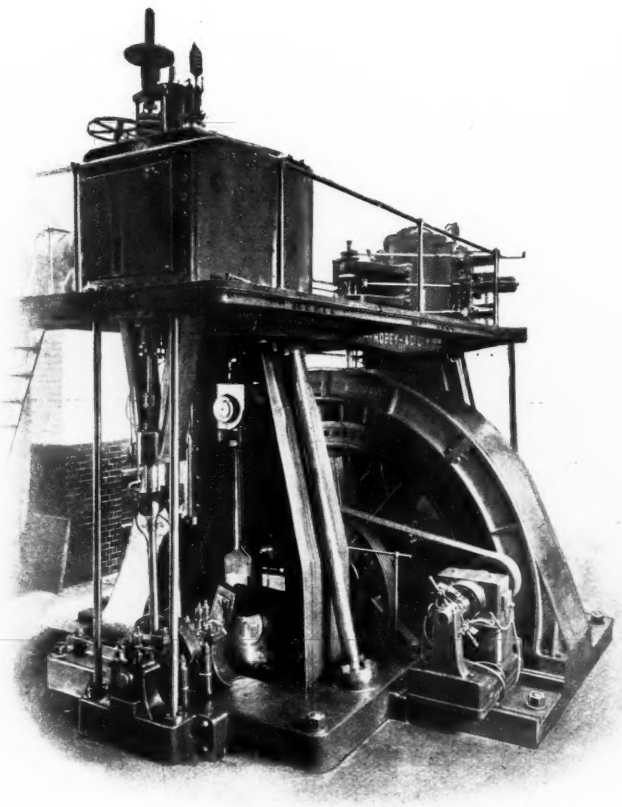
The class of consumer supplied consists chiefly of second-rate shops, and the day load is very small, being on an average 50 kw.

When the station was erected, room was allowed for an

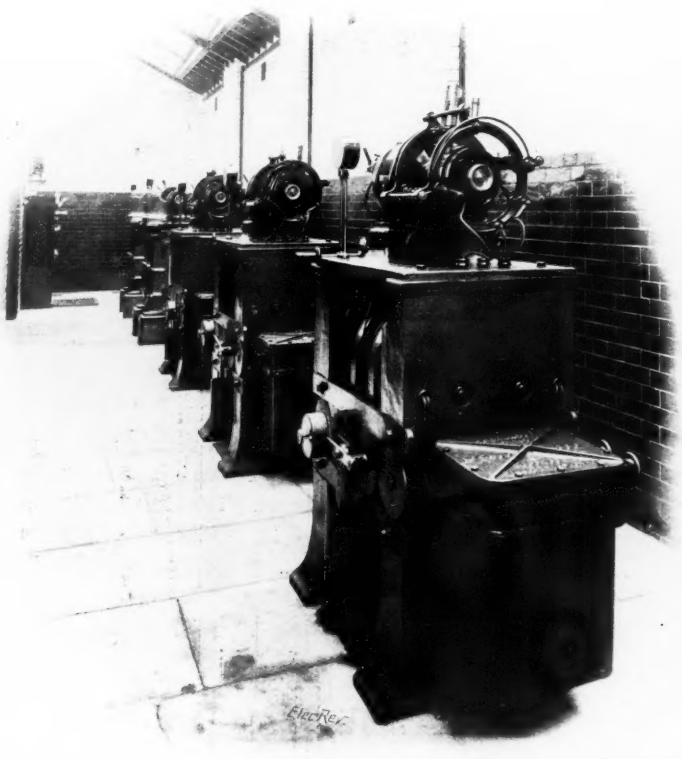
extra water-tube boiler, and this has now been supplied. A new boiler house and coal store are also in course of erection. A Green's fuel economiser (144 pipes) is placed in the main flue. As the president of the newly constituted Smoke Abatement Society is a resident of the Hammersmith district, one is tempted to inquire what the engineer-in-chief has to say about the smoke question. It seems that with Welsh coal and hand firing the works enjoy a practical immunity from black smoke. On one or two exceptional occasions complaints have been lodged, but generally speaking there is little trouble.

The new Babcock and Wilcox water-tube boiler is of 212 H.P., and is complete with fittings. It forms one of a series of three, set in continuous battery, and all of equal power. It has a heating surface of 2,437 square feet, and a grate surface of 44 square feet. The general construction follows the well-known type of Messrs. Babcock and Wilcox's double-drum boiler, in which a series of 4-inch tubes, sloped at an angle of 15°, are connected to the front and rear ends of the steam and water drums by so-called headers. Wrought-steel is used throughout in this boiler with the exception of the mud drum, which is of cast-iron.

An important accessory, forming part of the boiler proper, is a superheater, composed of long tubes, 1½ inches in diameter, and bent into the form of a long "U," the ends being simply expanded into wrought-steel boxes. The superheater has a heating surface of 340 square feet. The superheated steam, after traversing the whole length of these tubes, is collected in the boxes and passes from these through three 4-inch diameter pipes, which connect to a cross above the boiler drums, from this through the stop valve and isolating valve to the steam piping. A cross-drum, 20 inches diameter, is placed above the steam and water drums from which saturated steam can be drawn from the boiler. Access is obtained to the interior of the boiler by the usual hinged doors, while the entire exterior surface of the tubes can be effectively cleaned from soot at any moment by the opening of a cock, which allows steam to issue in the form of fan-shaped jets above and around every tube in the boiler. The fittings include a deadweight safety valve, a high and low water alarm, 6-inch and 2½-inch steam stop valves, two feed check valves, enabling the boiler to be fed by a duplicate main, besides the usual pressure and water gauge fittings. A saddle gangway runs across the top of the boiler, permitting easy access to the steam stop valves.



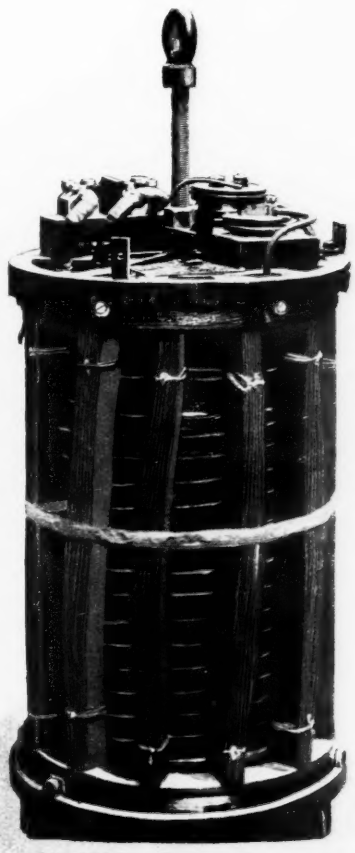
Single Set.



Rectifying Room.

Steam is supplied to two vertical cross compound condensing engines, by Robey & Co., Ltd., of Lincoln, with cylinders 17½ inches × 35 inches × 2 feet stroke, working at 150 revolutions per minute with a steam pressure of 140 lbs. per □″ The high pressure is fitted with Richardson and Rowland's patent Tripp cut-

off motion, automatically controlled by the governor and adjustable when running, the low pressure with ordinary slide valve, with Mayer's cut-off for hand adjustment. Both high and low pressure cylinders are fitted with steam jackets connected to traps, a jacketed receiver is placed between the two



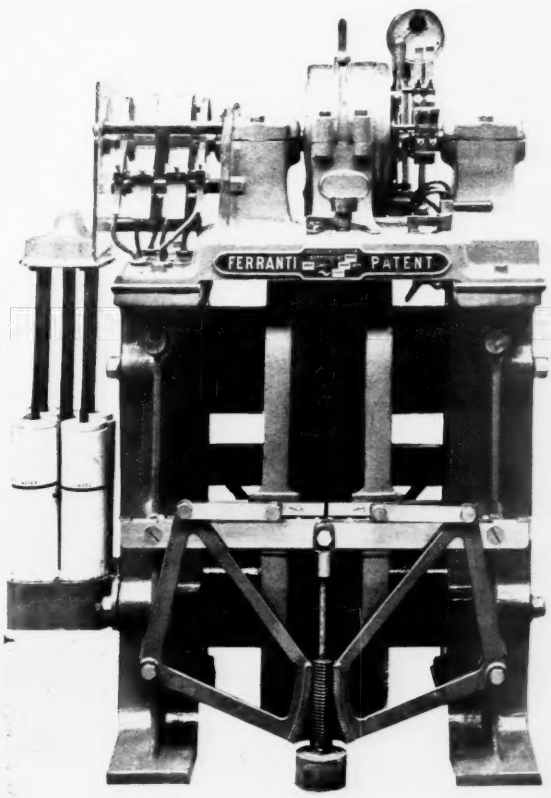
Berry Transformer.

cylinders and all are lagged with non-conducting material and covered with blue steel which gives a neat and finished appearance. The cylinders are mounted on cast-iron standards and stayed with bright steel columns in front, the standards forming the guide for the crosshead. All bearings are lubricated from overhead tanks with distributing pipes, and the oil is returned to the tanks by pumps on each engine. Suitable splash guards prevent oil from splashing on to the alternator and exciter. A large steam separator is fixed on each engine bedplate close to the stop valve and connected by copper pipes to a steam trap, as are also the drains from the cylinder jackets, receiver, steam chests, &c. All bearings are white-metal lined. The nominal H.P. is 500 non-condensing, and an emergency load of 600 H.P. when condensing.

From the line of engines in the main building the steam is carried direct to one of Ledward's patent evaporative condensers, designed to condense 20,800 lbs. of steam. This plant is arranged in duplicate, and the connections are made to allow of extension in the future without interfering with continuous working. The condenser is connected by branches to the upper or inlet ends in such a manner that the steam as it descends to the outlet to the air pump is condensed, and passes direct to the air pump. The form of pipes used is claimed to give a larger amount of cooling surface per pound of steam to be condensed than any other type. With this condenser a vacuum of 26 inches to 28 inches of mercury is steadily maintained.

To the left of the main station is an annex, in which a steam driven combined feed and air pump and electrically driven circulating pumps are in position. The air pumps, which have been supplied by Messrs. W. H. Allen, Son and Co., of Bedford, are of the well-known twin single acting type driven by a compound engine, the air pumps being connected directly to the crossheads of the pistons by means of side rods and cross bars, the piston rods themselves being connected to the double-throw crank by means of ordinary connecting rods. The cylinders are compound, the diameters being respectively 9 inches and 14 inches, both having a stroke of 8 inches. The air pumps are 16 inches diameter × 8 inches stroke, and are fitted with gun-metal liners and gun-metal valves, seats and guards, the valves themselves being of India-rubber. A heavy fly-wheel is fitted to the crankshaft to ensure steady rotation. A governor is also fitted to prevent the engine racing in case of accident. The speed at which this plant runs is about 110 revolutions per minute, and at this speed it is capable of dealing with 21,000 lbs. of steam per hour. Two circulating pumps are also supplied of Messrs. Allen's "Conqueror" type. They are 4 inches diameter and have discs 15 inches diameter. Each pump is driven by an alternate current synchronous single-phase motor, and is capable of discharging 10,000 gallons per hour against a total head of 51 feet when running at a speed of about 960 revolutions per minute. The exhaust pipes run up through this room to the condenser on the roof.

The alternators are constructed by the Electric Construction Company, Limited, of Wolverhampton. Each alternator is built between the beds of the engine, the normal output being 135 amperes, with 2,300 volts, and maximum load 158 amperes, 2,300 volts, at a speed of 150 revolutions per minute. The periodicity is 50 per second. The insulation

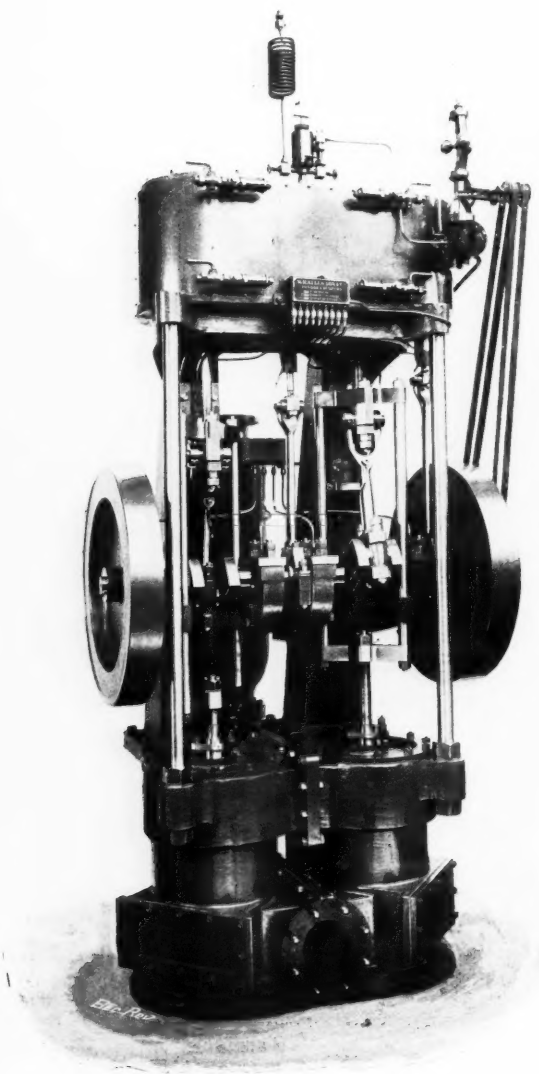


New Rectifier.

resistance between the armature and frame is not less than 10 meghoms, and between the magnet coils and machine frame not less than 5 meghoms.

The armature is stationary and built in 20 segments, each capable of being separately taken out and replaced when

necessary. The iron core is of ample section and composed of the very best charcoal iron sheets not more than ·015 inch in thickness, insulated from each other, the laminations being in the plane of the magnetic fields. The core is thoroughly insulated from the frame of the machine, and the coils again insulated from the core by means of tubes, composed almost entirely of mica. The conductor will not carry more than 1,500 amperes per square inch of section. The field magnet poles are the revolving part of the machine and are 40 in number, consisting of a cast-iron fly-wheel with steel pole-pieces securely fixed thereto; the current density in the field magnets is not more than 800 amperes per square inch. It is specified that, after ten hours running at normal output, the temperature of the armature shall not rise more than 60° F., and the magnet coils not more than 30° F. above that of the surrounding air. The terminals are erected on porcelain slabs at least 12 inches apart, and are thoroughly enclosed. The collector rings are of phosphor bronze, in two segments for coupling on the shaft. Each

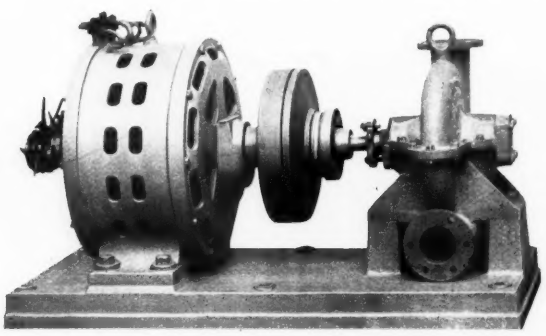


Air Pump.

ring is provided with two sets of brushes and brush-holders, either set being ample for transmitting the maximum current without heating, contact being made by adjustable springs, and each brush being provided with an insulated hold-off catch for keeping it away from the rim while the alternator is in use.

Each machine has its exciter driven by ropes from a separate pulley on the main shaft and is able to excite both alternators at maximum load without undue heating or sparking. All machines work in parallel, but arrangements are made in the main switchboard for running separate engines on separate circuits in case of necessity. The third set now erecting has a Ferranti alternator with copper disc armature.

The extensions to the high tension switch gear were carried out by Messrs. S. Z. de Ferranti, Limited, and comprised the addition of 10 panels arranged to deal with 10 feeders, the

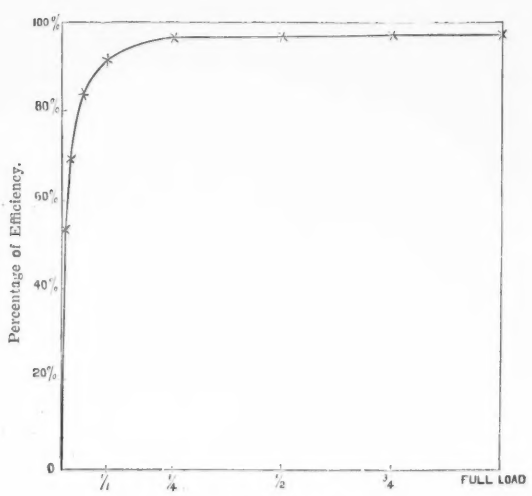


Circulating Pump with Single-Phase Alternating Current Motor.

feeder panels on the old portion of the switch gear being re-arranged so as to be made capable of dealing with alternators. The extension of 10 panels is exactly identical in every respect, with the original switch gear installed.

In regard to the street lighting, the current is rectified from 2,300 volts, alternating, for the purpose of lighting the three circuits of Brockie-Pell arc lamps which have just been completed. The two extension Ferranti rectifier sets are each capable of dealing with 50 lamps, and two extension sections of switch gear are also supplied for dealing with these rectifiers. The rectifiers are as shown installed in a separate rectifier room, and the old rectifiers, together with their switch gear have been removed and placed alongside the extension machinery.

The extension rectifiers themselves are in principle identical with the rectifiers originally supplied, but modified in a few details, which modifications are shown by reference to the illustration on page 641.



Efficiency Curve of 25-kw. Berry Transformer.

We understand that rectifiers in accordance with this photograph have given such satisfactory results that Messrs. Ferranti are enabled to standardise their manufacture, and by so doing can place upon the market a more finished article in reasonable time.

There are now 150 arc lamps in regular use on the street lighting circuits, and this allows two of the rectifiers to be held in reserve. Each arc lamp pillar is also fitted with two 32-C.P. incandescents for lighting after midnight.

Edmunds's automatic switch is fitted in the base of each post for switching in the incandescents as required.

The main feeders and distributing cables have been all supplied by Callender's Cable and Construction Company. For the purpose of the new private lighting six new sub-stations have been erected. Current is transformed from 2,300 volts to 110 volts in Berry transformers, supplied by the British Transformer Manufacturing Company, of London.

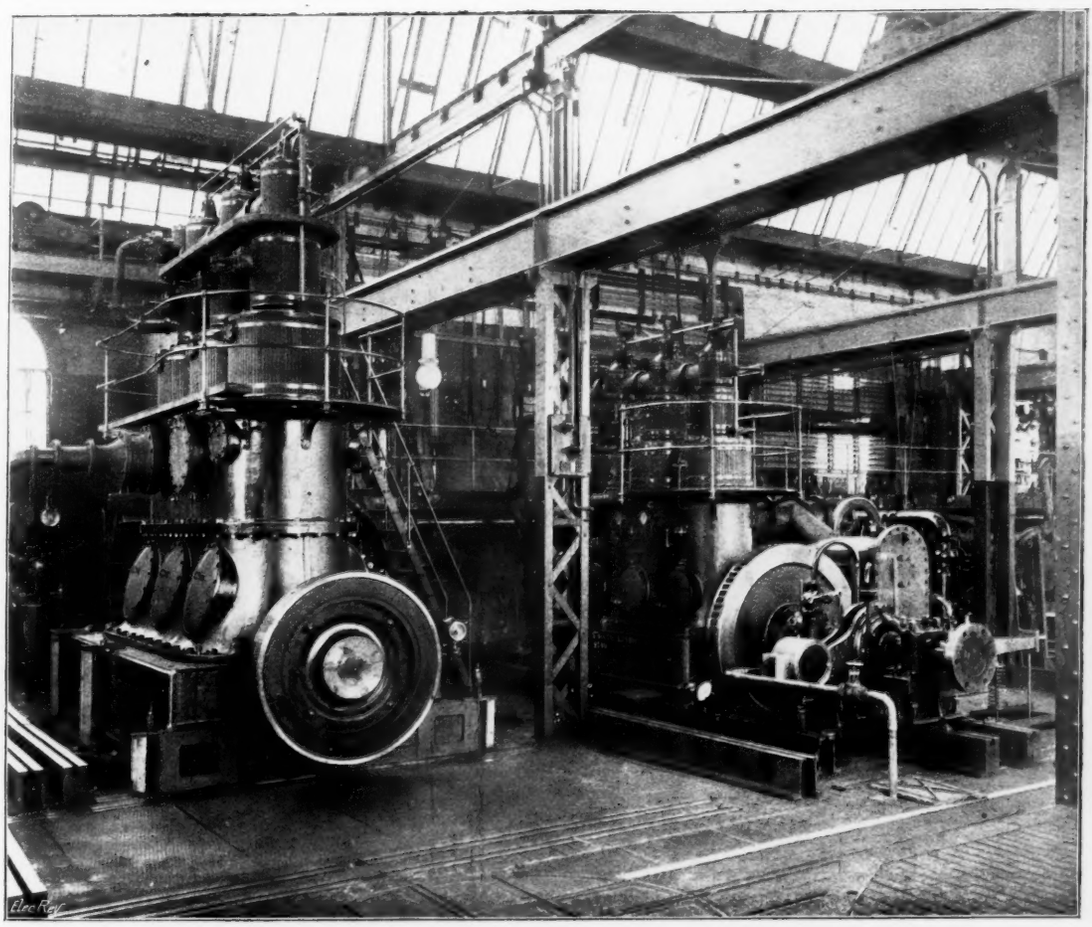
Each transformer is of 25 kw. nominal output. They are used in sub-stations or road boxes as required, either in parallel or in charge of separate circuits. The insulation was tested to double the working pressure applied after the transformers had run for 12 hours at full load inside the water-tight cases. We give the efficiency curve, as plotted, from the readings taken by the makers after 12 hours' run at full load. It will be noticed that the efficiency reaches 96 per cent. at ¼ load, and is highest—98 per cent.—at ¾ load, a very satisfactory result on a periodicity of 50 cycles per second. The tests were carried out at the Hammersmith station. The above 25-kw. transformers are enclosed in water-tight cases, and occupy a space 3 feet 6 inches high × 1 foot 9 inches in diameter, dimensions which are very convenient for road box working.

A new 20-ton overhead traveller has been supplied by Messrs. Marshall, Fleming & Jack.

The cost of the first extension is about £40,000, bringing the total capital expenditure, to date, up to £72,000. Further extensions are now in hand, and within the last 10 days contracts have been placed for three new Babcock and Wilcox boilers of 500 H.P. each, two Musgrave vertical compound condensing engines of 1,000 H.P. each, and two Siemens iron core alternators of 600 kilowatts output at 100 revolutions per minute. The extensions of street mains will be carried out by the Vestry, the cables being supplied by Messrs. Callender's Cable and Construction Company, the total cost of these being £16,000.

On the occasion of the inauguration of the extension in March, Mr. A H. Preece, the consulting engineer, showed that the first completed 12 months' working had been exceedingly satisfactory, the revenue being £9,225 and the working expenses £5,467, leaving a balance of £3,757, or a gross earning of 9½ per cent. on the total capital.

We are perhaps giving expression to what everyone having any knowledge of the subject would expect, when we say that Hammersmith is repeating the experiences of other authorities who have launched out upon such undertakings. The Vestry is able to congratulate itself upon the possession of a very promising installation, which is making rapid strides under the efficient control of Mr. Bell.



Willans & Robinson Engines, 1,000 Horse-Power on Left Hand.

ENGLISH ENGINES ON THE MOVE.

We intimated last week that Messrs. Willans & Robinson had under test the first engine they have made of the 3 V size, indicating 1,000 horse-power at most economical load, 1,200 H.P. as maximum continuous load, and 1,500 H.P. as emergency load. It is intended for dynamo driving for traction work, and is one of a set of eight ordered for the Liverpool electric tramway scheme. At the same time there was on the steaming bed an engine of 3 R size, to indicate from 500 to 600 H.P., one of the two ordered for the City and South London Railway Company.

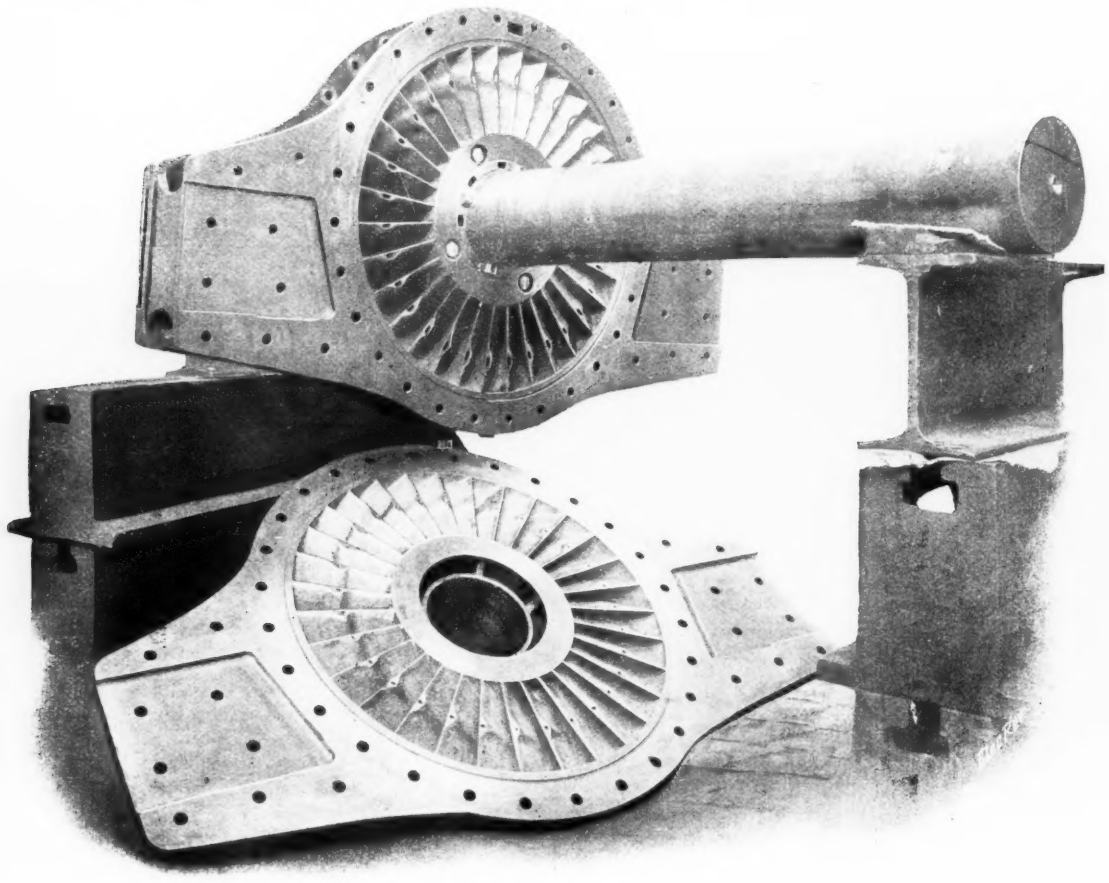
We believe that the engines turned out by the Rugby firm last year amounted in the aggregate to 40,000 horse-power; this year they anticipate an output of at least 60,000. We know of one firm of contractors, not 100 miles from Victoria Street, who have placed orders for the last-mentioned figure, and all the engines are to be of American manufacture.

The reasons which have led to the importation of engines from the United States are supposed to be generally understood, but whether we attribute these to the partiality of certain consulting engineers, to the inability of English engine makers to guarantee delivery at short notice, or, indeed, to quote even for the class of goods demanded for electric traction, Messrs. Willans & Robinson are making strenuous efforts to anticipate the requirements, so far as motive power is concerned, of those who have the giving out of large power tramway contracts. Therefore the far-seeing directors are constructing engines of 2,500 H.P., to be soon followed by others of 5,000.

Last week we had the pleasure of seeing both the engines above specified in operation, and in common with other interested visitors, including Mr. Chamen, and two of his Glasgow elders—we mean bailies—Mr. Faraday Proctor, Prof. Capper, Mr. Hammond, Mr. Aldridge, Mr. Cunningham, and several members of the Press, of complimenting Mr. Robinson and his colleagues on their enterprise and determination to spare no efforts to keep the firm not only abreast, but ahead of the times.

To the 3 V engine there will be coupled direct a Siemens 10-pole dynamo having an output of 1,420 amperes at 460 to 550 volts. The emergency load, as we have already stated, is 1,500 I.H.P., and the speed the engine is designed to run at is 230 revolutions per minute. The governing variation from full to no load is guaranteed not to exceed 1½ per cent., and if the whole load is thrown off during one second the momentary variation should not exceed 5 per cent., but this, of course, very largely depends upon the weight of the fly-wheel. As the engine has not yet been coupled up to its dynamo, nor so far provided with its own fly-wheel, proper governor trials had not, at the time of our visit, been carried out.

The emergency load of the 3 R engine is 585 B.H.P., and the most economical load is 470. The speed of this engine is 320 revolutions per minute, and it was coupled to an hydraulic brake consisting of two parts, viz., a disc fast on the shaft and provided with projecting blades which pass close to, but do not touch, other fixed blades upon the inside of a casing which is free to move on the shaft, but is kept from doing so by means of weights at the end of a lever. The power is put on the brake by forcing more or less water through the brake, the supply of water being regulated by a valve, and is measured by putting known weights at a definite distance from the centre until they balance the tendency of the casing to turn round on the wheel. The nearer the mixture of water and air passing through the brake approaches to solid water the greater is the power absorbed by the brake, which will absorb as much as 800 H.P. The brake as we saw it had one drawback, viz., that it was carried on two bearings of its own, the friction of which is not measured, and therefore tells against the engine. This friction being a very variable quantity, Messrs. Willans & Robinson are going to re-arrange the brake entirely, so as to do away with the bearings.



Willans & Robinson Engines.—Froude Hydraulic Brake.

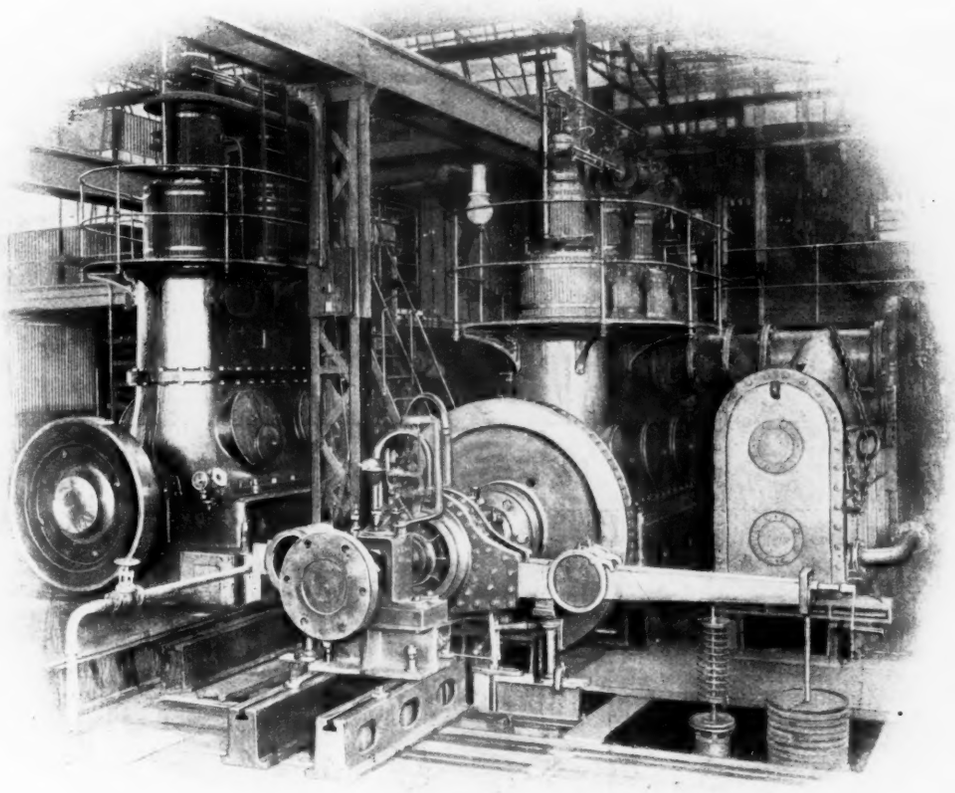
THE ROCK FALLS AT NIAGARA.

Early on the morning of Friday, March 31st, the earth in the northern section of the city of Niagara Falls trembled as though shaken by an earthquake, and when full daylight came, it was discovered that the earth's trembling was occasioned by a great avalanche of rock that had occurred in the Niagara gorge near the Buttery whirlpool rapids elevator. The weight of the mass that fell was many hundred thousand tons, and together it formed the greatest rock slide that has taken place from the Niagara cliffs in many years. At the point where the avalanche occurred the cliffs have an almost straight descent of 200 feet, so that the rock breaking away from the top of the bank fell with its unbroken force down on the tracks of the Gorge electric road and the buildings at the foot of the Buttery elevator. The greater part of these buildings were smashed into kindling wood, and about 40 feet of the lower part of the elevator shaft was torn away, thus rendering it impossible to operate the

elevator cars. One of the buildings had just been rebuilt, following its destruction by the fall of an old elevator shaft, which was torn from the cliff by a high wind some few weeks ago, and so disaster followed disaster.

The mass of rock on the electric road tracks was like a small mountain, and the force of the fallen mass had ruined the road-bed at that point and directed the rails almost into the rapids. One great piece of limestone that came from the extreme top of the cliff fell directly upon the tracks and crushed all beneath it into a shapeless mass. Had it gone a few feet further this great rock would have plunged into the rapids, but there is no doubt that much of the rock that fell did go into the rapids. An examination at the top of the bank revealed the fact that another great body of rock was preparing to fall, the seam between it and solid rock gradually opening. Policemen were stationed to guard all points of entrance to the gorge and also the locality about the loose rock in order that venturesome persons might be kept out of danger. Later on this mass of rock was blasted away by order of the mayor of the city.

This fall of rock has awakened anew the dangers of operating an electric road along the water's edge beneath the bluff. While there are numerous places where rock falls are looked for and expected, this was not one of them. In fact, the old elevator and the present elevator were located at this point owing to the recognised apparent solidity of the cliffs. The avalanche of March 31st is evidence that there is no telling just when or where tons of rock are likely to slip from the cliff into the gorge. Fortunately the Gorge road has not been in operation during the past winter, so the rock fall cannot be said to have in any way interfered with traffic on the line. However, that the avalanche occurred at such an early hour as 5 a.m. is extremely fortunate, for since the Gorge road has not been in operation the Buttery elevator has regained much of its old time prestige as a point from which to view the famous whirlpool rapids, and throughout the day many people are about at all hours. So, had the rock fallen during business hours of the morning or afternoon, it must have caught somebody beneath it and crushed their lives out. Near the spot where the slide occurred there has recently been some quite heavy blasting, which may have had a tendency to loosen the rock that fell, but the majority of people believe that the result was principally the effect of frost and spring weather.



Willans & Robinson Engines, with Froude Brake attached to Smaller One.

THE JUNGFRAU MOUNTAIN RAILWAY.

It need hardly be said that the application of three-phase current working on the Jungfrau Mountain Railway is of great interest to all engineers, because, unlike many of the reputed three-phase systems, the Jungfrau line provides an example of the actual use of three-phase motors on the cars. The section in operation at the present moment is part of a larger scheme, which will eventually carry the line through a series of tunnels to the summit of Jungfrau. Power is transmitted 8·5 km. from Lauterbrunnen to the point where the line commences, the current being three-phase and transmitted at 7,000 volts to the transformer stations placed at each terminus of the line, where the pressure is reduced to 500 volts. Rieter & Co.'s turbines are employed at the main power house, there being two groups of 500 H.P., running at 380 revolutions per minute. There are two over-

Jungfrau Railway.

The Rock Falls at Niagara.

head wires, the rails acting as the third circuit, and it will be noticed from the illustration that the locomotive is fitted with four trolley poles. The overhead work is not of an elaborate character, the wires being merely suspended from wooden posts. The locomotive weighs 12 tons, is fitted with two motors of 125 H.P. each, and usually draws two passenger cars at an average speed of 8·5 km. per hour. Naturally, on a line where the maximum grade is 24 per cent., a rack rail is employed, it being of a special type invented by Mr. Strub, the chief engineer of the line.

Work is being carried on continuously on the remaining sections of the line, and in the boring of the tunnels electricity is playing an important part, both in operating drills and in lighting.

ELECTRIC LIGHTING NOTES.

(*Continued from page* 638.)

Jedburgh.—It is stated that the Town Council had before it last week a letter from Messrs. Lorain & Purves, consulting engineers, Edinburgh, offering to get a provisional order for the installation of the electric light into Jedburgh free of charge by a London firm, and stating that a similar arrangement had been approved of by Hawick and Melrose. The Lighting Committee will make further inquiry and report.

King's Lynn.—The Corporation want an assistant electrical engineer, fitter driver, mains jointer, &c., for the electricity works. See our "Official Notices" this week.

Kilmainham (Ireland).—The District Council has under consideration a draft agreement, proposed by the Municipal Industries Syndicate, for the electric lighting of the township. Mr. C. W. Sax appeared before the Council recently to reply to questions on the subject.

Kirkcaldy.—The Town Council last week agreed to ask the Board of Trade to grant them the original clause giving them power to transfer their rights in their electric lighting order. It was stated that the Board did not like the clause, because it had not worked well in practice.

Leyton.—Last week the Electric Lighting Committee reported that the engineer had made a report stating that the number of lamps that can be connected to the mains when the new machinery is at work is about 19,000. As the number of lamps already connected amounts to 13,000, it is advisable to order additional plant at once. The cost of the general scheme will be approximately £24,086. In addition to this, the purchase price of the land necessary for the extensions will have to be provided for, and the Committee recommended that application be made to the Local Government Board to sanction a loan of £30,000 for the purpose of carrying out the extensions. The report was adopted.

During the past year the electric lighting undertaking made considerable progress, the number of 8 C.P. lamps connected increasing from 7,000 to 12,800. The supply to private consumers increased by 100 per cent.

London, E.C.—The *City Press* learns "on good authority" that the City of London Electric Lighting Company has approached the Corporation with a view to opening up negotiations for the discussion of the questions at issue between the two bodies on the subject of the future of the electric lighting of the City. Some weeks ago informal negotiations which were in progress were suspended at the time owing to the decision of the Board of Trade to open a public inquiry into the position of affairs.

Maidstone.—Last week a committee advised the Council to adopt a provisional scheme submitted by Messrs. Kincaid, Waller and Manville for the erection of electric light and dust destructor plant at Fair Meadow. The Council, however, passed an amendment that the scheme be not adopted, but referred back to the committee to present "a more reasonable scheme, free from the objections to the first one."

Manchester.—The Electricity Committee on Tuesday considered the estimates for the current year. The estimated income, chiefly from sales of current, is £82,500. After meeting all expenditure, it is anticipated there will be a surplus balance of £8,115. To this will be added £2,000 from last year's account, making a total disposable balance for the year of £10,115, of which £10,000 will be paid to the city fund. In the year just closed there was an actual profit of £16,754, out of which £12,000 was paid to the city fund, the remainder being held over. The estimated expenditure on capital account for the year is £203,400, the principal items being Dickinson Street station, £26,900, Bloom Street station, £18,200, Stuart Street station, £40,000, cable stores, £10,000, and mains, £86,200. For street lighting there is an estimate of £2,000, receivable from the city fund.

Morecambe.—Messrs. S. H. Heywood, of Ducie Street, Manchester, are busy with several important installations at Morecambe, including the West End Pier and Clarendon Hotel. At the last meeting of the District Council the tenders of Mr. James Proctor, of Burnley, for mechanical stokers for use at the electricity works was accepted. Mr. Councillor John Brown presented a report on the progress of the electric light works, under the direction of the engineer, Mr. Parkinson. The works were opened on June 28th, 1898, for public lighting, with only one engine in operation. The number of lamps switched on was 66, until the end of July, when the first private consumer was connected. By March 31st last they had received 200 applications for current for lighting purposes. There were 2,595 incandescent lamps connected. The private arc lamps numbered 32, and the private lights numbered 5,835. The number of public arc lamps is 104, and 85 gas lamp pillars have been converted into incandescent lamps. Asked what the deficit would be, Mr. Brown said the accounts had not been made out yet, but he hoped there would be none.

Newington.—Last week the Electric Lighting Committee as requested, presented a somewhat lengthy report, giving further particulars regarding the staff they proposed appointing for the electricity undertaking. Their recommendations were adopted, and they are now empowered to engage the various officials and staff.

Nuneaton.—It is stated that a syndicate has approached the Nuneaton Electric Light Company, Limited, with a view to purchasing its undertaking. On the other hand, there is a feeling that the plant should be in the hands of the municipality.

Oldham.—At the last Council meeting Councillor Johnson drew attention to the following in the minutes of the Electric Lighting Committee:—

> That the condensing engines supplied by Messrs. Carrick & Wardale for the electric lighting station be dispensed with, and that the superintendent be instructed to write, informing them that the engines have been unsatisfactory in their working, and requesting them to make an offer for the same. Mr. Andrew was also instructed to write Prof. Kennedy, informing him of the decision of the Committee, requesting him to state what other type of engine he recommended.

He asked if these engines had not been proved a failure; whether they were not put in on the recommendation of Prof. Kennedy—if so, why the Committee ask his advice on the matter.—Councillor Nadin asked what was the cost of these engines, how long they had been in, and what time had they been at work.—Alderman Harrop said that Councillor Johnson was correct; they had to rely upon Prof. Kennedy, he being their adviser, and they had had no cause for complaint on any other score. Prof. Kennedy had done all in his power to bring the makers to a sense of their obligations, but had failed. The small dynamo cost £385, and the larger was put in in 1896, and cost £615. He had asked Mr. Newington, and was informed that the condensers had not done a month's work. He could not answer the latter part of Councillor Johnson's question.—The minutes were then confirmed.

Oswestry.—The Council has confirmed the appointment of Mr. Hawtayne to report upon the value of the undertaking of the Oswestry Electric Lighting and Power Company.

Paddington.—The Metropolitan Electric Supply Company has given notice to the Vestry of intention to lay mains in a number of streets in the parish.

Partick.—The Electric Lighting Committee has been instructed to make full inquiry as to a suitable site for a station, and to employ an electrical engineer to advise the Committee as to the cost, &c.

Poplar.—The District Board has received the formal consent of the County Council to the position of the electric lighting station in Glaucus Street. The County of London and Brush Company have written to say that they have decided to no longer proceed with that part of their Bill seeking powers to light the Poplar district.

Ramsbottom.—A member of the District Council last week suggested that an electrical expert should be engaged to survey the district and prepare an estimate *re* electric lighting.

Redditch.—It is stated by the chairman of the Lighting Committee that the electric lighting scheme will be in working order for public and private supply in five or six weeks' time.

Rhyl.—The Board of Trade has decided to allow the Council to insert a clause in the electric light order empowering the Council to lease the undertaking if they so desired.

Ross.—The District Council on Monday decided to ask the solicitors to the promoters of an electric lighting scheme for the district to lay full particulars of the proposal before the next meeting.

Rotherhithe.—At last Friday's meeting a resolution was brought forward for that body to apply for a provisional order for electric lighting. After a discussion of some length the matter was adjourned for 12 months, the surveyor at the end of that time to report on the capabilities of the dust destructor, &c.

St. Pancras.—At the last meeting of the Vestry the Electricity Committee reported having had under consideration a suggestion made by the chief electrical engineer to connect the Regent's Park station with the King's Road station to enable the former to render assistance in meeting the increasing demand upon the latter. The estimated cost was £5,550, and on the recommendation of the committee the Vestry sanctioned the expenditure.

Shoreditch.—At a meeting of the Vestry on Tuesday Mr. Frost asked whether the members would have to wait until the annual report was circulated before they were acquainted with the actual position of the electric lighting undertaking during the year

ended March 25th. In reply, Mr. Adams, the Vestry's accountant, stated that the electric light and refuse destructor accounts could not be made up at present, because the liabilities had not yet been passed by the Lighting Committee and brought into the accounts. That would not be done for two or three weeks, when the accounts would be issued with the report of the Lighting Committee. It was decided on the recommendation of the Lighting Committee to sanction an expenditure of £2,350 on establishing two new arc light circuits of 20 lamps each in the neighbourhood of Nile Street. In this connection the Vestry referred back to the committee a proposal to obtain the arc lamp columns and carriers from the previous contractors to the Vestry in this class of goods.

Shrewsbury.—The recently-purchased undertaking of the Shropshire Company is to be considerably extended under municipal control, and £4,139 is to be spent in this way. The electrical engineer have drawn up estimates which have been considered by committee.

Sierra Leone.—Among the passengers who left Liverpool on Saturday by the *Batanga* were six Royal Engineers, who were going out to instal a system of electric lighting in the forts and other places. They came from Chatham.

Sleaford.—The expert's report *re* electric lighting is in the hands of the Council.

Southport.—On 11th inst. the Town Council had a long discussion on a recommendation of the Electricity Committee that application be made for borrowing powers for £55,000 for extensions of the plant and mains, £15,000 being required for traction purposes in connection with the tramways, which they expected to be in operation in 12 months' time.—Mr. Alderman Griffiths opposed the application on the ground that they had no information before them as to the probable revenue to be derived from the extra expenditure. It was not sound trading that they should extend an estate which only paid 1 per cent., at the expense of the gas estate, which paid 5 per cent. It was stated that the net profit for the year on the electricity estate was £1,950, this being the first sum available for the relief of the rates. It was eventually decided to refer the application back in order to consult with the Finance and Tramways Committees.

Sunderland.—At a recent Council meeting it was stated that the electricity undertaking showed for the past year a gross revenue of £6,683. This, after paying sinking fund and interest, leaves a gross profit of £1,657, while the total current expenses were £1,335, leaving a net profit of £320. Most of the tradesmen in the centre of the town have now adopted the light, and there is a growing demand for electricity in many outlying districts.

Swinton.—After pressure being used by the Swinton and Pendlebury District Council the Board of Trade has agreed to re-insert the transfer clause in the Council's provisional order.

Taunton.—The Council has decided to invite the Municipal Electrical Association to Taunton during their visit to Bristol in June next.

Tavistock.—Tavistock is amongst the towns which may be described as anxious for the introduction of the electric light. There is a good deal of dissatisfaction with the charges of the gas company and the inadequacy of the public lighting, and a supply of electricity at a moderate price would be eagerly welcomed.

Teignmouth.—The District Council has given approval to the provisional order for electric lighting.

Torquay.—The receipts of the electric light undertaking for the quarter ending March 25th, in connection with the Corporation electric light undertaking, exceeded those of the preceding quarter by over £140, the totals being £919 and £777.

Wallasey.—On 12th inst. a Local Government Board inquiry was held into the Council's proposed loan of £10,000 for electric lighting.

West Hartlepool.—At last week's meeting of the Town Council the Electric Lighting Committee recommended the following scale of charges for supplying electric light:—Not exceeding a consumption of 1,000 units per annum, 5d. per B. of T. unit; 1,000 and not exceeding 3,000, 4½d.; 3,000 and not exceeding 4,000, 4½d.; 4,000 and not exceeding 5,000, 4¼d.; 5,000 and not exceeding 6,000, 4d.; and that a rebate of 5 per cent. be allowed upon the excess where 6,000 units shall be exceeded. This was agreed to.

Whitby.—The District Council has resolved to purchase a site for electricity works for £1,540.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Alva.—At their monthly meeting last week, the Alva Burgh Commissioners had under consideration a letter from Mr. Purvis, Edinburgh, with reference to the installation of electric lighting in the town, and the building of a light railway between Alva and Tillicoultry. A favourable view was expressed by several of the members, especially with regard to the light railway. At present, although only two miles separates these two towns, there is no railway connection, and when the River Devon overflows its banks and floods the road, travellers have to journey *viâ* Alloa, a distance of nine miles by rail. A special committee, consisting of Provost Thomson and Bailies Arnot and McNicol, was appointed to look into the matter.

Ashbourn.—At the last meeting of the District Council a letter was read from the Light Railway Commissioners stating that they had submitted an order to the Board of Trade approving of the Derby and Ashbourn light railway. The overhead trolley system will be employed.

Ayr.—The Council has considered a proposal by Drake and Gorham Electric Power and Traction Company, but is not inclined to bind itself at present.

Bath.—By 8 votes to 7 the Surveying Committee has rejected the recommendation of the joint committee that applications be made to the Board of Trade for powers to erect lines under the Light Railways Act. The electric traction question is, therefore, shelved for the time being, but we suppose that is so only so far as municipal enterprise is concerned.

Belfast.—At last week's meeting of the Council in committee, Alderman Rt. Hon. W. J. Pirrie, J.P., brought forward some suggestions which he had formulated to enable the Council to come to a decision regarding the desirability of acquiring the street tramways. He produced estimates for the purchase of the lines, compensations to officials, &c., complete electric trolley installation and equipment. The proposals were submitted to a special committee to consider and report upon.

The town clerk (Sir Samuel Black) has drawn up the following statement prepared by himself:—

Rough Estimate of Value of Tramways as they may be Purchased in 1901.

57 miles of single line at £4,000	£148,000
150 cars at £100	13,000
1,040 horses at £20	20,800
Harness and stable fittings per horse	5,200
Stable and buildings	50,000
Fixed price of goodwill	2,000
Total	£239,000

If now Purchased at Price of the Day.

Capital of the company, 24,600 shares		£246,000
Premium at present price, £8		196,800
Debentures		60,000
		£502,800
Being an addition on estimated value of	£263,800	
Conversion and electric power		350,000
		£852,800
Interest and sinking fund thereon (30 years) at £5 2s. per cent.		£43,492
Depreciation on electric expenditure at 10 per cent.		35,000
Loss of rent		5,000
Requiring a net profit yearly till 1907 of		£83,492

Bradford-Leeds.—On 19th inst. the Board of Trade took into consideration the above light railway proposal, and interested parties were invited to be present to make their objections.

Bristol.—The Bristol Chamber of Commerce annual report reviews the history of the year in matters connected with electric traction, and says the citizens and the tramways company are alike to be congratulated on the prospects of the immediate conversion of the whole of the Bristol system to electrical working. Experience of the St. George and Fishponds electric lines proves that electric tramways are an important agency in the development of suburban districts. The total authorised electric lines in and around Bristol cover but little less than 30 miles of route. The capital expenditure of the company already exceeds £700,000, and when the works are completed it will total about £900,000. The reserve funds of the company are now £81,000, and the last dividend paid was at the rate of 7 per cent. per annum. The total revenue receipts last year were £145,505, and the net profit £40,439. The company carried on their cars and 'buses during the 12 months 23,324,855 passengers.

The Bristol Tramways and Carriage Company is pushing forward with the electrical equipment of its lines. Mr. George White states that the line from St. Augustine's to the railway terminus will be ready for running by the first week in July. The new central station which will be needed for supplying the converted lines and for the new lines will not be ready so soon. A good deal of work was necessary in the site at Counterslip before the building could be erected, and in order that the wharf wall might be constructed a large coffer dam had to be fixed so that the artisans might work below the level of the river. The St. George power house can, however, furnish enough current for the station line, and thus the company are enabled to open that much-used section without waiting for the completion of their Counterslip undertaking.

Dover.—A Board of Trade inquiry will be held on 26th inst. in regard to the Council's application for sanction to borrow £7,350 for additional works and other matters in connection with the Dover Corporation Tramways Order, 1896.

Dundee-Broughty Ferry.—On 14th inst. Sir Courtenay Boyle, at the Board of Trade, heard objections to the confirmation of the Dundee and Broughty Ferry light railway order. The hearing stands adjourned until 29th inst.

Eastbourne.—On 11th inst. the Town Council instructed the borough engineer to prepare plans for tramways or light railways for certain routes. The daily press says that an electric tramway scheme for certain routes avoiding the parades has been practically decided upon.

Exeter.—Negotiations have been re-opened with a view to the transfer of the Exeter tramways to the City Council, who are anxious to acquire the undertaking and equip it for electric traction. It is too early yet to speak with any assurance of the probable result of the negotiations. There can, however, be no doubt that Exeter and its suburbs would be greatly benefited by an extension of the tramways, and by such an improvement in the means of operating the cars as electricity would introduce.

Glasgow.—A Lords' committee on Tuesday passed the preamble of the Bill promoted by the Corporation to extend its tramway system to a number of important areas lying outside the municipal boundary. The only point contested in the Bill had reference to the town of Paisley. The Corporation have, however, come to an agreement with the Corporation of that town to acquire the tramway undertaking when it falls to be purchased by the Paisley Corporation three years hence, and the Corporation of Glasgow will work not only the Paisley system but also the line of tramways running through the county of Renfrew and connecting Glasgow with the Paisley system.

Greenock.—The Police Board Special Committee on the 14th inst. considered the report of Mr. Young, manager of Glasgow tramways on the questions of municipalising or leasing. It is stated that Mr. Young is of opinion that the Corporation should take over the system, and that the tramways could be worked by them at a profit.

Ingleton.—In addition to the electric lighting scheme now on foot, it is stated that a movement is in progress for the construction of an electric railway to the summit of Ingleborough. The scheme will come under the Light Railways Act.

Lambeth.—The Vestry at the last meeting considered a letter from the London County Council asking for the consent of the Vestry to the Council's application to the Board of Trade for the experimental use of mechanical traction on the tramway between Westminster Bridge and Tooting. Mr. H. J. Smith, vestry clerk, stated that notwithstanding this request, the County Council were presenting at this late period of the session a petition asking for permission to introduce a Bill to authorise the use of the overhead trolley, the conduit, or the surface contact system on the Council's tramways, and that the Council were seeking to dispense with the consent of the Vestry as the road authority, and that the Council had not even given any intimation to the Vestry of the intention to override the latter's authority. Mr. H. White expressed surprise that the Council were trying to supersede the Vestry. As one of the members who recently met a sub-committee of the Highways Committee of the London County Council, in conjunction with representatives of the Streatham Vestry and the Wandsworth Board of Works, he mentioned that the Council placed no scheme before them. The chairman of the sub-committee wanted to hear the views of the three authorities, and hinted at the desire of the Council to introduce the overhead trolley system. The speaker stated that, as far as he was concerned, the Lambeth Vestry would oppose overhead wires, whereupon the chairman suggested that something else might be used on the Lambeth section and the overhead trolley commence at Clapham Rise. The representatives for Streatham and Wandsworth immediately rose and objected to this, and they all left the conference under the impression that the Council would outline some scheme, so that the different local authorities might have an opportunity of considering the question on its merits. The speaker was surprised to hear the Council were now going behind their backs, and he hoped they would strongly oppose the trolley system.—Mr. Wightman said the Council were trying to steal a march upon them; it would have been more straightforward for the Council to have informed them what they intended to do. He moved that the Vestry clerk should be instructed to take immediate steps to oppose by counsel in committee the application to dispense with the Standing Orders of Parliament, and that the Council should be informed that the Vestry were prepared to consider the application to the Board of Trade on the Council specifying the motive power proposed to be used and the manner in which it was intended to apply it.—Mr. Philpot having seconded the motion, Mr. Willis stated that he believed the best system the Council could adopt was the surface contact method. If they waited 12 months he believed they would get that instead of the trolley. After some further discussion the resolution was unanimously adopted.

Light Railway Routes.—In the House of Commons on Tuesday, Sir J. Maclure asked the President of the Board of Trade whether his attention had been called to the issue of orders for the construction of light railways along main thoroughfares in populous districts, and whether, in view of what had already been done in this respect, he would consider the propriety of suspending any further orders until the opinion of the Law Officers of the Crown as to the legality of the action of the Board and of the Light Railway Commissioners in this matter could be ascertained. Mr. Ritchie: No, Sir; the Board of Trade were advised at the outset upon the legality of the course which has been adopted, a course which has now become well-settled practice.

Middlesex County Council.—The Middlesex County Council are about to take steps to constitute themselves the electric and light railway authority for the county, and have instructed their surveyor to prepare plans of roads suitable for light railways. They have also asked local authorities to proceed no further with existing schemes.

Newcastle-on-Tyne.—After his return from America Prof. Kennedy proceeds to the Continent, and he will not be able to furnish his report until the end of May or beginning of June. A South of England electrical firm has written to the Council with reference to electric trams, and an interview is to be granted by the new Tramway Committee. In the event of the Corporation Bill passing through the House, Mr. Charles Hopkins will be appointed chief superintendent engineer, and an assistant superintending engineer will be engaged at £500 per annum. These recommendations have to come before the Council.

Norwich.—The Tramway Committee brought up at Tuesday's Council meeting a recommendation that upon an agreement being entered into by which the Corporation secures full rights to regulate the traffic of the Norwich Electric Tramways Company in St. Stephen's Street to any extent which, in the judgment of the Corporation, the public interest may require, permission be given to the company to make a tramway in the thoroughfare named, and that the town clerk be directed to affix the Corporate seal to such agreement.

Oldham.—The Oldham, Ashton-under-Lyne, and Hyde and District Electric Tramway Company have given notice of their intention to apply to the Board of Trade under the above tramways order of 1896 for an extension of time for the completion of the works authorised by the said order to August 7th, 1899.

Perth.—The Commissioners have appointed a committee to enter into negotiations with the Perth District Tramway Company for the purchase of the tramways. It was stated last week that the proposal arose out of a discussion in regard to the application by the company for leave to introduce electric traction, and also for the extension of the lease to 28 years. They granted the first request, but refused the extension of time. The motion had been delayed from the last monthly meeting in order that they might have the report of Mr. Hawtayne, the city's consulting electrical engineer, before them. Mr. Hawtayne had strongly recommended that the two systems should be combined.

Richmond.—At the last meeting of the Richmond Town Council, Alderman Thompson moved that a conference be held with neighbouring authorities as to the advisability of uniting in a system of electric or light railways in the locality combined with electric lighting, in connection with the dust destructor scheme. The proposal was defeated by one vote.

Rouen.—An order for six large Westinghouse steam engines and 15 dynamos has just been placed for the power station in connection with the Rouen electric tramway.

Southampton.—At the Council meeting last week the Electric Lighting and Tramways (Joint) Committee reported having considered a report of Mr. Manville, in relation to the most economical method of supplying electrical energy to the tramway system. The proposal he made to the Electric Lighting Committee to utilise the existing machinery for the supply of the current to the tramway system by the use of a battery of accumulators for the heavy load times was, he was convinced, the most economical way to supply current to the trams, at least, while the system was a small one. As regards capital cost, such a scheme would be very much cheaper than installing fresh boilers, steam pipes, engines, and other auxiliary machinery devoted solely to the tramway system. As regards maintenance, the cost would be certainly no greater than if separate plant were installed and worked, involving the firing of additional boilers during heavy load time, and probably necessitating the employment of another stoker and engine driver during one shift, not to talk of the extra amount added to the cost of the unit by the additional interest and repayment of capital involved on the much larger capital outlay. The question was raised as to whether the loss in the accumulators would not be excessive. That was not so. As at present proposed the accumulators, so long as the spare lighting plant was in working order, would only do half of the work of the trams during heavy load times; and whilst undoubtedly on this half of the work a loss of 25 per cent. in the energy generated will be made, this represents a loss of only 12½ per cent. on the total tramway load during the four heavy hours of lighting, or on the total tramway supply for a day of, say, 14 hours, say a loss of about 3½ per cent. on the whole tramway supply, which was, of course, quite insignificant. Further, this loss of energy would only be incurred during the dark months of the winter. During the rest of the year the maximum lighting load supply would be fortunately reduced so as to enable the lighting engines to supply the tramway load during the heaviest hours of the day without any help from the accumulators. In the future, when the tramway load was much increased, he agreed it would be desirable to further consider the desirability of putting in a separate generating plant, either for the additional tramway load thus involved, or for the whole. In that event the accumulators now installed for the tramway load can be most economically applied to meet the increased demand for lighting, which would certainly arise, in place of installing further boilers and engines that would otherwise be necessary for this purpose. As to the successful use of the combined system of steam generation and accumulators for electric supply, this was exemplified by the very successful installations of the type in some of their principal cities, such as Manchester, Birmingham, Edinburgh and several London municipal and companies' stations, not to speak of the numerous large installations of this description on the Continent, and the several cases of the use of such systems in purely tramway generating stations not used for any other purpose, such as Blackpool, Douglas and Leeds, very many on the Continent of Europe, and some in the United States. The Joint Committee, having fully considered the report and estimate of the proposed new works, recommended the Council to adopt the report and estimate of the Electric Lighting Committee, and to apply to the Local Government Board for sanction to borrow the sum of £17,159. Councillor Lauder was against. The Council last week adopted this report.

Twickenham.—The Twickenham District Council have come to terms with the London United Tramways Company, under which they will offer no opposition to the proposals of the company to construct a light electric railway through their district.

West Ham.—A deputation from the Town Council inspected the Glasgow electric trams a few days ago.

Wolverhampton.—Mr. J. W. Bradley, the borough engineer and surveyor, has supplied to the Press a few interesting particulars respecting the proposed new tramways for Wolverhampton. He says that the lines will be constructed on the most improved and substantial manner possible, with heavy steel flat bottomed girder rails, buried in 6 inches of Portland cement concrete, then granite setts or wood blocks set in pitch grout will form the road surface immediately adjacent. The rails will weigh 110 lbs. per yard, with heavy fish plates and sole plates. The joints will be electrically bonded with heavy copper bonds, and both rails and tracks will be frequently cross bonded. The system of traction will be the overhead trolley, with side brackets and pillars, with an arm connecting the cars with the wire running along the side of the street. The cost of the permanent way will be about £140,000, of which £80,000 will be spent in paving and concrete underbed. The side poles, section boxes, trolley wires, feeder mains, &c., will cost nearly £48,000, and the car depôts, cars, &c., another £40,000. It is expected, if all goes well, to have some of the tramways ready for use about the middle of 1900.

TELEGRAPH AND TELEPHONE NOTES.

The Atlantic Cable viâ the Azores.—In view of the objection which the Government of the United States has always manifested to allowing the landing of cables on American territory which are the property of companies holding exceptional privileges under concession from other Governments, it would appear that the completion of the trans-Atlantic cable which is proposed to run from the Azores to the United States will not be effected altogether without difficulty.

Imperial Telegraphic System.—It is stated that an important meeting, at which 20 members of Parliament who have taken special interest in Imperial questions have agreed to attend, will be held in one of the committee rooms of the House of Commons on Tuesday, 25th inst., to consider a scheme to be submitted by Mr. Henniker Heaton, M.P., for cheapening Imperial telegraphic communication. A daily paper says that whether the hon. member for Canterbury's plan is adopted or not, a motion will be proposed that the Governments of India, South Africa, Australia, and New Zealand shall hold a conference with the home Government with the object of reducing the present high cable rates, which, for social messages, are regarded as prohibitive. Some Indian, Australian, and South African merchants will address the meeting.

Manchester Telephones.—By 39 votes to 21 the City Council has decided to send a deputation to the Postmaster-General supporting the application of the Mutual Telephone Company for a licence. The Special Committee had previously resolved that it was not to do so, but the Council has not approved.

The Pacific Cable.—On Tuesday last in the House of Commons, Mr. Hogan asked the Secretary of State for the Colonies whether Her Majesty's Government had now arrived at an understanding or agreement with the Governments of Canada and Australasia in reference to the construction of a Pacific cable, as recent proceedings in the Parliament of the Dominion of Canada would seem to suggest.—In reply, Mr. Chamberlain said: "No, sir; the matter is still under consideration."

The following extract from the *Morning Post* indicates the reason for this reply:—"Sir Wilfrid Laurier has now let the cat out of the bag, so to speak, as to the delay in the matter of presenting to Parliament the report on the Pacific cable. It appears that neither the report nor the correspondence which has passed on the subject between Australia, New Zealand, and Downing Street is to be made public until Canada has introduced a Bill into the Dominion Parliament authorising the colony to make a contribution of five-eighteenths towards the accomplishment of the scheme. Sir Charles Tupper takes my view, that the construction of the cable involves no obligation whatever on Canada, as there is abundant evidence that the line will pay. Why, had we only had a cable to Samoa during the last few weeks the press messages alone would have been sufficient to pay a considerable portion of the yearly expenses, while with the Government messages between the islands and Great Britain, America, and Germany thrown in, the sum total would have been considerable. It must be remembered that the line is a commercial as well as a political one, and, except in the case of war, it would be open to take all messages, irrespective of the nationality of the sender. The question of representation on the Board of Control has been a difficult matter to fight, and Australia, as usual, wanted to pay the smallest sum and have the largest representation. Of course, that was impossible, and Mr. Chamberlain has, I believe, settled the matter by dividing the management in accordance with the contribution. It is satisfactory to know that the matter is at last receiving some attention, and it might be well for some member of Parliament to press for a few further particulars."

The Proposed German Telegraph Line to India.—In the convention recently concluded between the German Empire and Roumania for direct and rapid communication between Berlin and Constantinople, *via* Bucharest, Tchernavoda and Constanza, provision is made for a reduced tariff for the consignment of telegraph material for cables and landlines.

The Telegraph Wire Export Trade.—March proved to be a very quiet month as regards the exports from this country of telegraph wire and apparatus connected therewith, the month's shipments only attaining a value of £21,870, as compared with £95,424 in February last, and no less than £135,583 in the corresponding month of last year. The fluctuating character of this trade is well shown by the returns for the first quarter of the present year, which are summarised below:—

	1899.	1898.
January	£311,466	£39,929
February	59,424	75,276
March..	21,870	133,583
Three months	£392,760	£248,788

It will be seen, however, that, taking the quarter as a whole, it has been an active one, the total being largely in excess of that recorded for the same period of last year.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Amazon Company's cable—		
Cable beyond Gurupa ...	June 11th, 1898 ...	...
French Company's cables—		
Cayenne-Pinheiro ...	March 10th, 1899 ...	...
Para-Maranham	April 10th, 1899 ...	...
Landlines.		
Communication between Mossamedes and all Inland Offices.	March 16th, 1899 ...	...
Communication between Salonique and Monastir.	March 23rd, 1899 ...	...
Siberian landlines between—		
Blagowestschensk-Khabarowka.	April 12th, 1899 ..	April 13th, 1899.
Irkoutsk-Werkhne Oudinsk	April 17th, 1899 ...	...
Fao landlines between Bagdad and Bassora.	April 11th, 1899 ...	April 15th, 1899.
Majunga-Tananarive ...	April 13th, 1899 ...	April 13th, 1899.
Saigon-Bangkok ...	April 17th, 1899 ...	...

Telephone Progress in the West of England.—The report of the Bristol Chamber of Commerce presented to the annual meeting held on Wednesday, the 19th inst., contained references to the telephonic system of Bristol and the West of England. Early in the year, the document says, serious complaints reached the Council of the Chamber of the interruption to communication on the trunk lines between Bristol and Plymouth. Accordingly, representations were made to the General Post Office authorities upon the subject, and the answer was to the effect that just prior to the date of the complaint several working parties were engaged on the lines, which probably caused the interruption, but now that the lines were in order, the postal authorities hoped that no further difficulty would be experienced. There are, however, the Council of the Chamber said, on frequent occasions very serious delays, which point to the necessity for the early provision of additional trunk lines between Bristol and the towns in the West of England. Representations were also made to the Council of the Chamber upon the inefficient trunk line service between Bristol and London. The secretary to the Chamber of Commerce communicated with the Bristol postmaster and surveyor, and was informed that the department would lose no time in completing and bringing into use a second trunk line between Bristol and London. With reference to the nationalisation of the telephone system, the Council expressed their views in the following resolution:—"That having regard to the disadvantages arising out of the present working of the telephone service under the dual control of Government and the National Telephone Company, it is the opinion of the Council of this Chamber that the Government should take immediate steps to acquire the undertaking of the telephone company upon just and reasonable terms as between the nation and the company's shareholders."

The Telephone Question.—The Nottingham City Council has passed a resolution strongly objecting to the scheme proposed by the Financial Secretary to the Treasury for dealing with the telephone question, on the grounds:—(1) That no provision is being made out of Imperial funds for the large provincial towns, as is proposed for London; (2) that London subscribers will get the benefit of Imperial expenditure, and be free from the 10 per cent. royalty provincial subscribers have to pay; (3) that the proposal to allow a municipality to compete until 1911 with the National Telephone Company, where the company is well established in a town, can only end in a loss to the rates, and inconvenience to the public, and that, if the competition is to be carried on, it should be by Government.

The Council of the London Chamber of Commerce proposes to urge upon the Government that it is undesirable that the Postmaster-General should licence the Councils of county boroughs, as proposed in the Telephone Bill now awaiting second reading, to provide systems of public telephonic communication, pending the report of the Joint Committee about to be appointed by the two Houses to consider the whole question of municipal trading.

Telephones in the States.—A Bill for the regulation of telephone charges in the State of New York, drawn up by the committee appointed for that purpose by the New York Board of Trade and

Transportation, was recently introduced simultaneously in the Senate and the Assembly. A daily paper says that the Bill provides that the telephone rates in cities of 1,000,000 inhabitants and over shall not exceed $125 a year; in cities of 500,000 to 1,000,000, not to exceed $85; in those of 100,000 to 500,000, not to exceed $48; those of 20,000 to 100,000, not to exceed $35; from 8,000 to 20,000, not over $30; and in all places having less than 8,000 inhabitants, not to exceed $27 a year. The charge for local messages at public or pay stations is fixed not to exceed 10 cents for the first five minutes, and 5 cents for each additional five minutes. Provision is made that the rates may be raised if the telephone company is not making, in addition to the amount paid for interest on bonded indebtedness, a net profit of 10 per cent. upon all cash capital, while, on the other hand, it may be lowered if the company is making a profit of more than 10 per cent.

Wireless Telegraphy.—In the House of Commons on 13th inst., Sir R. Penrose Fitzgerald asked the President of the Board of Trade whether, in view of the fact of breakages of the telephonic cables between lightships and the shore having taken place from time to time, he would consider the desirability of adopting the wireless system for one or more of the light-vessels recommended by the Royal Commission on Electrical Communication, and not connected by cable at the present time. Mr. Ritchie, in reply, said: The possibility of adopting the wireless telegraphy system between light-vessels and the shore is a very important question, and is receiving very careful consideration, but I am not yet in a position to express an opinion with regard to it.

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria.—April 23rd. Tenders are being invited until the 23rd inst. by the municipal authorities of Brunn for the supply of four Edison dynamos (model K) of 200 amperes and 110 volts capacity, one small and two large Gramme dynamos for arc lighting, three boilers of the Dufuis type to work at a pressure of 105 lbs. and one 100-H.P. steam engine with Colmann valve gear. Tenders to be sent to Der Magistrat, Brunn, whence particulars may be obtained.

Battersea.—June 7th. The Vestry wants tenders for the supply of mains, water-tube boilers, steam dynamos and engines. See "Official Notices" April 14th.

Belfast.—April 27th. The Electric Committee wants tenders for road-work and laying cables, &c. See "Official Notices" April 14th.

Ealing.—May 1st. The Council wants tenders for the supply and erection of two Lancashire boilers with superheaters and accessories. See "Official Notices" this week.

Edinburgh.—April 24th. The Corporation wants tenders for a 12 months' supply of steam coal, arc lamp carbons, cast-iron pipes, &c. See our "Official Notices" April 14th.

Epsom.—May 8th. The District Council wants tenders for various plant for its electricity undertaking, including boilers, dynamos, boosters, batteries, switchboard, crane, mains and road-work, arc and incandescent lamps, and for the lighting of the station. See our "Official Notices" April 7th.

France.—May 4th. Tenders are being invited by the French Post and Telegraph Authorities in Paris for the supply of 666 metres run of paper-insulated electric cable. Particulars may be obtained from Le Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris, to whom tenders are also to be sent.

Hampstead.—May 18th. For the purpose of extensions at the electricity works, the Vestry wants tenders for two 500-kw. steam alternators, five switchboard panels, boilers, feed water heaters, Weir's feed pumps, a 50-kw. exciter, water softening plant, air pump and condenser, Green's economiser and overhead crane. See "Official Notices" April 7th.

Kingston-upon-Hull.—April 25th. The School Board wants tenders for an electric light installation for the Central Higher Grade School, and School of Science in Brunswick Avenue, Beverley Road. Particulars from Mr. O'Donoghue, clerk, School Board Offices, Albion Street, Hull.

London.—April 24th. The London County Council requires tenders for the supply of engineers' goods and electrical stores. Full particulars may be obtained on application to the Clerk to the Council, County Hall, Spring Gardens, S.W.

Morley.—April 26th. The Corporation wants tenders for the wiring and fittings required at the public baths. Particulars from Messrs. Holtom & Fox, architects, on payment of £1 deposit.

Poplar.—April 25th. The Board of Works wants tenders for engine and boiler house plant, battery equipment and street lighting. See "Official Notices" March 17th.

Reigate.—May 1st. The Town Council wants tenders for water-tube boilers, pipe work, two 100-kw. and one 30-kw. steam alternators, overhead crane, sub-station equipment, switchboard, mains, lamp-posts, &c. See our "Official Notices" April 7th.

St. Pancras.—May 16th. The Vestry wants tenders for additional engines, dynamos, &c., at the Regent's Park Station. See "Official Notices" this week.

Sunderland.—April 21st. The Guardians require tenders for the necessary wiring, lamps, &c., as well as all cables, stoneware casings, and boxes in connection with the lighting by electricity of the new Workhouse Infirmary. Plans and specification at the offices of Messrs. W. & T. R. Milburn, architects, 20, Fawcett Street, Sunderland.

West Ham.—April 21st. The Council wants tenders for two 1,500-I.H.P. engines, and two 800-kw. alternators and exciters, or two 800-kw. 1,500-I.H.P. steam alternators and exciters. See our "Official Notices" March 31st.

CLOSED.

Burton-on-Trent.—Last week the Council confirmed the Committee's proposal to give a contract to Messrs. Tinkers, Limited, for the supply of certain boilers. Market Hall and Market Square are to be lighted electrically.

Ealing.—Orders have been placed with Messrs. Babcock and Wilcox for 2 800-H.P. water-tube boilers, fitted with superheaters.

Glasgow.—It is stated that the offer of Messrs. M'Dowall, Steven & Co., of Milton Ironworks, is to be accepted for electric lamps to be erected on Glasgow Bridge. The same posts will carry the trolley wires.

Gloucester.—In our note last week of the acceptance of tenders by the City Council, it was incorrectly announced, owing to a copyist's error, that the British Insulated Wire Company, Limited, has been allotted the contract for public lamps. We ought to have stated that the tenders for this section of the work are still under consideration.

Rothesay.—The Town Council has accepted the offer of Messrs. Lowdon Brothers, Dundee, to fit up the electric light installation for the front of the town and harbour at a cost of £2,501, the whole work to be completed before the middle of July.

Shoreditch.—The Vestry on Tuesday accepted the tender of Messrs. Humms & Co., for the supply of boiler fluid for the Electric Lighting Department, and that of Messrs. Middleton Brothers, for engineer's stores.

Southampton.—For the wiring and fitting of the Isolation Hospital with 402 lights and cables to allow for extensions, the City Council has accepted the tender of Messrs. Lankester & Sons, Limited, at £599 15s.

Stockport.—We understand that Messrs. McLure and Whitfield, of Stockport, have secured the Corporation's order for their extension plant, consisting of 2 140-kw. dynamos at 500 volts with spare armatures. They will be coupled direct to Willans and Robinson engines. The first plant consisting of 3 56-kw. Mersey-Willans combinations has been working some time.

FORTHCOMING EVENTS.

Thursday, April 20th.—At 7.30 p.m. Civil and Mechanical Engineers' Society, Hôtel Victoria, S.W. Paper on "The Design of Wheels and Pulleys," by Prof. Arch. Sharp, B.Sc., &c.

Friday, April 21st.—At 5 p.m. Physical Society. Agenda:—1. "On the Effect of a Solid Conducting Sphere in a Variable Magnetic Field on the Magnetic Induction at a Point Outside." By Mr. C. S. Whitehead, M.A. 2. "Demonstration of Richards's Method of Standardising Thermometers." By Mr. R. A. Lehfeldt, D.Sc.

At 7.40 p.m. North-East Coast Institution of Engineers and Shipbuilders, Newcastle-upon-Tyne. Among other arrangements, a paper on "Shop and General Establishment Charges in Engineering Works and their Relation to Costs and Estimates," by Mr. W. E. Cowens.

At 4 o'clock. Prof. Ewing will repeat his "James Forrest" lecture on "Magnetism" before the Institution of Civil Engineers.

Wednesday, April 26th.—At 7.30. Institution of Electrical Engineers. Students' meeting in the Library. A discussion will be started by Mr. F. S. Miller.

Thursday, April 27th.—Institution of Electrical Engineers. "Experiments on Alternate Current Arcs by aid of Oscillographs," by W. Duddell, Wh.Sc. and E. W. Marchant, B.Sc., associates (conclusion of discussion); "Capacity Measurements of Long Submarine Cables," by J. Elton Young, member.

Saturday, April 29th.—Institution of Electrical Engineers. Students' visit to the Central London Railway. Particulars will be given on post cards.

NOTES.

Electrical Plant Insurance.—A few weeks ago we referred to a move made by the National Boiler Insurance Company in the direction of electrical plant inspection and insurance against breakdowns. We understand that the Engine, Boiler and Employers' Liability Insurance Company, Limited, have been doing this class of business for the past ten months. This company undertakes the inspection and insurance of electrical machinery and fittings in mills, factories and private houses in the same way as it has acted with respect to steam engines and boilers. We are informed that Mr. L. Foster, who was for nine years with the Westminster Electric Supply Corporation, has been appointed electrical engineer to the company, and forms of application may be obtained at the offices, 49, Queen Victoria Street, E.C., or at 12, King Street, Manchester.

The Luminescence of Welsbach Mantles.—In connection with the Nernst lamp, a good deal of discussion has taken place as to the cause of the superior luminescence of the oxides of rare earths used in the said lamp and in the Welsbach mantles. In the *Electrical Review* (N.Y.), March 15th, Prof. Elihu Thomson puts forward a theory essentially different from that given by Mr. Swinburne in his paper at the Society of Arts. Prof. E. Thomson thinks that these oxides have no superiority over other refractory substances in their emissive power, but they cause a combination of the uncombined gases in the flame by absorption in their pores, and thus produce a higher temperature and consequently more intense light. In support of this view, he states that in the oxidising flame of a blowpipe, or in the electric arc, the rare oxides show no superiority over other refractory substances, such as a carbon filament. The lime-light is much more intense when the reducing flame of the blowpipe is used, as he thinks, for the same reason. Mr. McTighe, in the following number of the *Electrical Review*, contests these views by pointing out that filaments of different refractory substances placed in the reducing flame are not all equally luminescent. A filament of pure thoria gives a moderately good light, but one containing a very small percentage of ceria emits a light of dazzling brilliancy. Mr. McTighe found that an intensely brilliant light may be produced by platinum wire gauze on a modified Bunsen burner. An air blast is added to the burner till the solid flame produced over a Welsbach gauze tip is reduced to a field of light blue cones of flame less than $\frac{1}{8}$ inch high. A piece of very fine platinum wire gauze, moulded to dome shape, corresponding to that of the tip of the burner, and held so as to be just in the tips of the blue cones, emits a light of remarkable power, reaching some hundreds of candles per square inch of gauze. The whole subject evidently requires further investigation.

Earth Currents.—Before the Royal Institution last Friday, Prof. A. W. Rucker lectured on "Earth Currents and their Relation to Electric Traction." Referring to the effects of escaping traction currents upon observatory instruments, he said that the instruments at Toronto and Washington have been rendered quite useless from these causes, showing that the earth conveyed the electrical currents for long distances through its crust to the great possible injury of scientific research as conducted in such places. In the neighbourhood of London, he proceeded to say, they had been met in a very reasonable spirit by the promoters of electric railways in their efforts to get such a system of using the current adopted as would ensure the return to the generating station of waste electricity. With the continuance of this reasonable spirit and the advance in electrical technology he was certain that at Kew and such places they might view with less and less alarm and anxiety the growth of the great industries depending upon the use of electricity. Carrying the matter further, the Professor suggested that as electrical currents had been unquestionably shown to be transmitted for long distances through the earth, the day might come when means would be desired of signalling from one side of the earth to the other without wires, or even from planet to planet!

Foreign Competition in Machinery.—The following letter from the pen of "Manufacturer" appears in the *Times*. It touches upon one of the most important phases of the subject of foreign competition:—

> It may interest the public to know that the delay in delivering machinery and iron structures by manufacturers in this country arises, to at least a considerable extent, from the over-abundance of our supply of engineering talent.
>
> A new design is almost invariably submitted to the manufacturer for every electric installation or bridge he is invited to tender for, and it is, therefore, impracticable to anticipate wants and give prompt deliveries by having machines or girders or the sections of iron required in stock. In America it is otherwise. There the manufacturers have standard designs to which they adhere, and decline to spend the extra time and cost involved in constructing machines of special type; the engineer, in short, has to adapt his designs to the standards of the manufacturers.
>
> In this country so great is the competition among manufacturers that each has to get up special designs, and (if he get the contract) make new patterns to carry out the ideas of the electrical engineer.
>
> This system, it is evident, must add greatly to the cost of the machinery as well as to the time required for its construction and delivery.

A subsequent letter, presumably from the same writer, referring to Lord Cromer's statement respecting the Atbara Bridge contracts, asks if it is possible to ascertain definitely the real cause why English orders for railway plant and machinery go the United States. He wants to know whether the tenders invited in England were on a design and detailed specifications by Lieut.-Colonel Gordon or the railway engineer; whether the American tender accepted is on the same design, &c., or on a design and specification submitted by the contractors, and, if the latter, whether tenders on a similar basis were invited from English bridge builders. In the course of this letter it is stated that:—

> In the United States, where prompt delivery is usually more urgently demanded than in this country, the railway engineer depends, in ordinary cases, on the manufacturer to supply, on his own design and specification to meet the necessities of the case, the article required. Under this system it is very evident that the American manufacturer has a great advantage in cost and delivery—both usually go together—for it is an axiom that the longer a job is in the shops the greater its cost. Manufacturers are always anxious to standardise the machines they make, and the great obstruction is the engineer's fertility in design

Wireless Telegraphy and the Trans-Atlantic Cable Companies.—The *Westminster Gazette* has interviewed Mr. J. H. Carson, the manager of the Anglo-American Telegraph Company, as to the probable effect of the wireless telegraph experiments upon the existing cable companies. Mr. Carson made it clear that British cable companies, while recognising the enormous scientific value of Marconi's discovery, did not at present regard the new telegraphy in the light of a rival likely to seriously encroach upon their commercial preserves.

> "In the first place," observed Mr. Carson, "I fail altogether to understand how Marconi is to counteract the great curvature of the earth met with across the Atlantic; how he thinks he can erect two perpendicular poles high enough on the shore, which will permit of the current being transmitted in the way he demonstrates. In France the Eiffel Tower has been talked of as a station, but it would surely require an Eiffel Tower nearly reaching to the clouds for a trans-Atlantic wireless telegraph to be satisfactorily worked. There is a great difference between 'cross-Channeling' at 30 or 40 miles and 'cross-oceaning' at 4,000! If he proposes to obtain the assistance of lightships, balloons, and other aerial instruments in order to lessen the enormous distance intervening between each station, the cost would be something almost inconceivable. And who is to pay? Will the Government? Why, they won't even pay us for experimenting in a mild way—and we dispatch 1,000 messages on the duplex cable every day. It has cost us something like £90,000 to mend a single broken cable; and from England to New York, by way of Valentia and St. John's, the laying of a cable comes to something like £150 a mile, or one million sterling the whole distance, then there is the terrific expenditure involved in laying and maintaining four separate cables, and could we but see our way to adopt cheaper facilities, the welcome would not be less than the reduction in outlay."

Lecture.—At Belfast, on 11th inst., Mr. J. N. Finnegan, B.A., B.Sc., lectured, under the auspices of the Natural History and Philosophical Society, on "Luminous Discharges in Rarefied Gases."

Tesla on the Wehnelt Interrupter.—Tesla lets himself out on the Wehnelt interrupter in the *Electrical Review*, (New York), March 15th. He invented this device two or three years ago. This belated publication in our contemporary would not, according to the generally accepted code, secure to Tesla the credit of being the inventor, but Tesla evidently does not regret this, since he considers there is no merit in the invention. It wastes, in his opinion, 90 per cent. of the energy, and is objectionable for other reasons which he does not specify. He mentions another interrupter based on a different principle which is incomparably more efficient, and also simpler on the whole. It comprises a fine stream of conducting fluid which is made to issue, with any desired speed, from an orifice connected with one pole of a generator, through the primary of the induction coil, against the other terminal of the generator placed at a small distance. This device gives discharges of a remarkable suddenness, and the frequency may be brought within reasonable limits, almost to anything desired. He has used this device for a long time in connection with ordinary coils and in a form of coil of his own with results greatly superior in every respect to those obtainable with the form of device discussed.

More Orders for American Locomotives.—What with the Midland Railway, the French State Railway, and other orders for locomotives, the American engine makers have reason to be filled with satisfaction just now. They are reaping a harvest on account of the disabilities of the English manufacturers. We have looked upon India as our own for orders almost as much as the Midland Railway Company. But the Indian Government has now placed an order for 45 locomotives with Philadelphian engine builders. They are of various sizes, and include several to be specially adapted for the mining districts.

Automatic Block Signalling.—We have received from Mr. C. E. Stretton a copy of a letter written by him to Mr. Little repeating an offer made years ago to pay him £500 in gold if he can prove his right to call himself the inventor of block signalling in 1865, or that he has any just claim against the Government. As this correspondence is, however, closed, we cannot publish the letter.

Electric Light and Fires.—Mr. A. H. Howard, the consulting engineer, says that the Hyde Park Court fire was *not* caused by fusion of electric light wires, as has been reported. There is such a liking on the part of the daily press to attribute nearly all large fires to this cause that one might almost think they were gas shareholders.

Wireless Telegraphy.—It is stated that the directors of the Wireless Telegraph Company have agreed to enter into negotiations with the syndicate which desires to obtain the exclusive rights of connecting England and America by wireless telegraphy.

Lord Kelvin.—On Tuesday, at the meeting of the Court of Aldermen at the Guildhall, Lord Kelvin was admitted to the Freedom of the City through the Spectacle-maker's Company.

Appointment.—We understand that Mr. W. C. P. Tapper, who was for nearly five years one of Mr. Arthur Wright's chief assistants at the Brighton Electricity Works, and who has since for some time been his chief engineer in his London work, has now been appointed resident electrical engineer to the Whitechapel District Board of Works, to carry out the electric lighting of that district under Mr. Wright's supervision.

CITY NOTES.

The Cuba Submarine Telegraph Company, Limited.

The report of the directors for the half-year ending December 31st, 1898, to be presented at the fifty-fifth ordinary general meeting of shareholders, to be held on April 26th, 1899, states that from the accounts it will be seen that the receipts amount to £27,483 17s. 11d., and the expenditure to £7,585 1s. 9d., leaving a sum of £19,898 16s. 2d., which, added to the balance of £3,713 11s. 6d. brought from the last account, leaves £23,612 7s. 8d. at the credit of revenue account. The traffic receipts show a considerable increase as compared with the corresponding period of last year, owing to the exceptionally heavy Government traffic consequent on the Spanish-American war. The sum of £10,000 has been added to the reserve fund, which now stands at £120,000. The dividend on the preference shares will absorb £3,000, and leave £10,612 7s. 8d., out of which the directors recommend the payment of a dividend at the rate of 6 per cent. per annum, and a bonus of 2s. per share, on the ordinary shares, both free of income-tax, the balance, £4,212 7s. 8d., being carried forward to the current half-year. At the date of the last report, the cables broken during the war had been repaired, with the exception of the Cienfuegos-Casilda cable and the 1891 cable between Cienfuegos and Batabano. The repairs to these have been completed during the current half-year, and the cost of the whole will form the subject of a claim against the United States Government, which will be put forward as soon as the accounts have been prepared.

Indo-European Telegraph Company.

The report of the directors for the year 1898, to be presented at the meeting to be held in London on 27th inst., states that the company's revenue from all sources for 1898 amounted to £134,643, as compared with £130,347 for 1897, showing an increase of £4,295. The expenses were—on commercial and general account, £37,131; on maintenance account (expenses and charges), £37,215; total, £74,346, as against £69,379 for 1897, an increase of £4,967. Deducting these expenses, taking credit for £9,073 brought over from 1897, and debiting income-tax, there remains £67,202. From this amount £15,000 has been placed to reserve, and that, together with £10,625, amount of interim dividend, have to be deducted, leaving a balance of £41,577. The directors now propose the declaration of a dividend for the six months ending December 31st of 17s. 6d. per share, making, with the dividend already paid, 6 per cent, and a bonus of 20s. per share, both free of income-tax, making in all 10 per cent. for the year, carrying forward £9,702 to the credit of 1899. The balance carried forward is again large, but considerable additional expenditure upon maintenance account, which it is prudent to provide for, will, in all probability, have to be made during the current year. The lines of the company continue to work satisfactorily, and the extension of the Wheatstone automatic apparatus, which in part accounts for the extra outlay on expenses and charges for maintenance, has proved successful; the system has now been established from Emden to Teheran. An additional wire has also been erected from Warsaw to Odessa.

The Oriental Telephone and Electric Company, Limited.

The report of the directors for the year ended December 31st, 1898, to be presented at the fifth ordinary general meeting of the company, to be held at the Cannon Street Hotel, London, on Wednesday, April 26th, 1899, at 12 30 p.m., states that the revenue account shows a balance to credit of £10,955 3s. 9d. transferred to profit and loss. Including the sum of £964 8s. 3d. brought forward from 1897, and after deducting £2,853 8s., the amount of interim dividend paid in November last, there remains £9,061 4s. for disposal. The directors propose to deal with this sum as follows:—To pay a final dividend of 8½. per share, free of income-tax, making 5 per cent. for the year, to transfer £2,000 to reserve, and carry forward £1,344 8s. With regard to the Indian subsidiary companies, the Bombay Company has again paid 6 per cent. for the year, whilst the Bengal Company has paid 5 per cent., as against 7 per cent. for the previous year, carrying forward Rs. 20,000 as a precautionary measure against possible temporary outlay. The Telephone Company of Egypt has declared its usual dividend of 6 per cent. on its preferred shares. The company has recently entered into an agreement with the Government of Egypt to continue the Government telephone service for a period of 25 years from January 1st current. Its business in general progresses favourably. The China and Japan Telephone Company has paid its debenture interest, but its accounts for the past year have not yet been audited. They point, however, to a larger surplus than in previous years. With a view to improving the telephone service at Shanghai, which would have involved a large expenditure of money, the directors of that company, through its local manager, approached the Council of the Shanghai Settlements some years ago in order to obtain, if possible, a prolonged term of concession so as to justify the outlay. The Council has now decided to grant a 30 years' concession, but has invited tenders by public advertisement. The directors of the China and Japan Telephone Company have sent in a tender, but the result so far is not known. The electric lighting branch of the company's business shows a small surplus, which has been carried meantime to a suspense account to provide for expenses in connection with a change of management now being proceeded with in Calcutta. Under Article No. 65 two directors retire at the meeting, and these are

Mr. B. St. John Ackers and Mr. Henry Grëwing, who, being eligible, offer themselves for re-election. The meeting will also be asked to pass a formal resolution confirming the appointment as a director of Mr. H. Johnstone Grëwing, and the consequent increase in the number of directors from five to six.

The Guildford Electricity Supply Company, Limited.

In presenting the annexed accounts and balance-sheet for the year 1898, the directors point out that the balance of profit on the revenue account, after taking into consideration the allowance of £150 for depreciation, amounts to £149 2s. 8d. In the net revenue account the directors have written off £77 14s. 6d. being 20 per cent. of the amount charged to preliminary expenses, to the end of 1898. Since the general meeting last year, the directors have had mains laid in London Road and parts of Edgeborough Road and Clandon Road, also in Park Street, Bridge Street, Onslow Street and Chertsey Street, and they have authorised the laying of further mains in Haydon Place, Martyr Road, York Road, Epsom Road and further part of Edgeborough Road. This extension of mains has necessitated further expenditure in machinery and plant. There are now 79 contracts with customers for supply of energy for electric lighting, as against 52 in March last year. Some of the old customers have largely increased the number of their lights, and the directors are expecting several new customers shortly. The directors have during the past year reduced the price of current for lighting purposes from 8d. per unit, with varying discounts, to 6d. net, and hope that this change will, in the long run, prove beneficial to the shareholders as well as to the customers. It will be necessary for the company to continue spending more capital for mains, machinery, and plant, and for this purpose further capital is required. Shareholders are asked to increase their holdings, in order that the necessity of paying commission for placing fresh capital may be avoided. In view of the probable increased demand for electric energy in the near future, the directors are now applying to the Board of Trade for an extension of the company's area of supply, and hope to obtain an order during the present Session of Parliament, adding the rural parishes adjoining the borough of Guildford within a radius of three or four miles to the company's present area. It is considered most important for the future of the company that this extension should be obtained.

The National Electric Free Wiring Company.

An extraordinary general meeting of the shareholders of the above company was held on Wednesday last at the offices, 8 and 10, Charing Cross Road, under the presidency of Mr. R. Stewart Bain, C.A.

The Chairman said the object of the meeting was to confirm the resolution passed on March 24th last for altering the name of the company. On that occasion he explained fully the reasons for the change, and he would now, therefore, content himself with formally proposing the confirmation of the resolution, as follows:—"That the name of the company be and it is hereby altered from the National Electric Free Wiring Company, Limited, to the National Electric Wiring Company, Limited."

Mr. W. R. Davies seconded the resolution, which was carried.

Great Northern Telegraph Company, Limited.—

The directors' report for the year 1898 states that the net receipts, including the amount brought forward, were £378,723. After payment of debenture interest and interim dividend, £295,972 remains, out of which an extra dividend, making 12½ per cent. for the year, is proposed, carrying £61,417 forward.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending April 15th, 1899, were £222 17s. 1d.; aggregate to date, £3,346 1s. 8d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending April 14th, 1899, were £2,542 17s. 4d.; corresponding period, 1898, (Easter week), £3,273 4s. 4d.; decrease, £730 7s.

The City and South London Railway Company.—The receipts for the week ending April 16th, 1899, were £1,050; week ending April 17th, 1898, £945; increase, £105; total receipts for half-year, 1899, £17,301; corresponding period, 1898, £16,771; increase, £530. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending April 15th, 1899, were £151 6s. 6d.; week ending April 16th, 1898, £180 7s.; decrease, £29 0s. 6d. Total receipts to date, 1899, £2,261 6s. 3d.; corresponding period, 1898, £1,695 4s. 2d.; increase, £566 2s. 1d. Miles of track open week ending April 15th, 1899, 3; week ending April 16th, 1898, 3. Car miles run week ending April 15th, 1899, 4,945; week ending April 16th, 1898, 3,075. Number of cars, week ending April 15th, 1899, 11; week ending April 16th, 1898, 7.

The Dublin United Tramways Company.—The receipts for the week ending Friday, April 14th, 1899, were as follows:—D. U. T. Co., horse cars, £1,754 19s. 4d.; ditto, electric cars, £947 4s. 2d.; D. S. D. Co., electric cars, £656 4s.; total, £3,358 7s. 6d.; corresponding week last year—D. U. T. Co., horse cars, £2,786 1s. 6d.; ditto, electric cars, £540 10s. 0d.; D. S. D. Co., electric cars, £700 8s. 6d.; total, £4,027 0s. 0d.; decrease, £668 12s. 6d.; aggregate to date, £49,314 6s. 8d.; ditto last year, £46,467 14s. 2d.; increase to date, £2,846 12s. 6d. Worked:—The mileage open is 18 miles electrically, 26 miles by horses, as against 11 miles electrically, and 31 miles by horses, for the corresponding period last year.

The Liverpool Overhead Railway Company.—The receipts for the week endin April 16th, 1899, amounted to £1,404; corresponding week last year £1,736; decrease, £332. 1898 includes Easter Monday.

The South Staffordshire Tramways Company.—The receipts for week ending April 14th, 1899, were £614 8s. 7d.; aggregate receipts for 15 weeks, £9,203 4s. 2d.; week ending April 15th, 1898, £856 16s. 2d.; aggregate receipts for 15 weeks, £8,939 6s. 3d.

STOCKS AND SHARES.

Wednesday Evening.

The market for electric lighting shares has found its business and attention confined almost exclusively to City of London's. "City lights! City lights!"—the cry has resounded every day in the Miscellaneous Market of the Stock Exchange, but there has been more noise than business, and the parcels of shares that have actually changed owners have been mostly in 20's and 25's. Considerably more pluck has been infused into the hearts of the buyers, and the price shows a rise of 15s. on the week at 17⅞. Metropolitan Electrics rose in sympathy with "City's," and at 17½ mark an advance of the fraction. Charing Cross have also put on ¼ at 11¼. County of London and Brush Provincial Ordinary are 11¼, the price being a trifle lower on the throwing out of the company's Bill by a Committee of the House of Commons. We continue to hear reports of a coming new issue of capital by the St. James's and Pall Mall Company, but no details are at present available. The ordinary shares retain their last week's improvement and are still 18.

The Central London's Bill was read for the third time in the House of Commons last Tuesday, but no change has occurred in the quotation of the shares, both the fully and partly paid being quoted 5s. either side of their par value. City and South London are a dull market at 69, and very little business has been recorded in Waterloo and City Ordinary, the price of which is about 110½.

It is when we come to the list of telegraph shares that the most numerous changes are noticeable. A somewhat unreasonable fear has seized telegraph shareholders, who are so frightened by the experiments in wireless telegraphy that they are clearing out of their holdings apparently regardless of cost. Naturally enough, the trend of affairs is soon discovered by the dealers in the market, who mark down prices as a precautionary measure, even though little or no stock has been offered. The weakness has been most pronounced in Eastern Telegraph Ordinary, and a sensational drop has lowered the price from 179½ to 162½, at which it is difficult to find a buyer. Eastern Extensions are down 1⅞ at 16¼, despite its excellent report. A "bear" attack upon Anglo-American Deferred has reduced the price to 13, and the ordinary stock has fallen to 62, fears of German competition accelerating the fall. The scare, we are inclined to think, has been overdone, and the man who is brave enough to buy Easterns at 163 will probably not regret it. The Great Northern Telegraph Company proposes to pay a final dividend, bringing the rate for 1898 up to 12½ per cent., with £61,417 forward.

The Manchester Carriage and Tramway Company has had a record half-year, the report lately issued showing that nearly £250,000 had been taken in tram and 'bus fares during the last six months. Most of the tramlines over which the company's carriages run belong to the Corporation of Manchester, and in 1901, when the license expires the overhead system, with electric traction, is to supersede the present arrangement. It is a moot point as to whether the company shall be taken over by the Corporation or not. From a financial point of view such a proceeding would most likely mean more profit for the Manchester ratepayers than they get now, but under new management perhaps the present success would be difficult to maintain. Manchester "A" shares are 29½, the "B" 19½, and the "C" issue 15. Bordeaux trams have been a strong market all the week, and at 19½ there seems to be room for a further appreciation if the company is taken over by the Teutonic group, who are negotiating the matter. Anglo-Argentines relapsed a trifle after the digestion of the report.

A final dividend of 8d. per share on Oriental Telephone shares makes 5 per cent. for the past year, but the price is unchanged at ⅞—15/16.

There is a rise in Babcock and Wilcox to 38, and in Willans and Robinson to 10½. The American companies, however, have had a bad week, and prices of traction shares slumped heavily in the fall which took place among American Railroad shares. The reaction has brought a recovery in prices, but the market in New York is still suffering from the inflated boom in "Industrials" during February and March.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation, April 12th.	Closing Quotation, April 19th.	Business done during week ended April 19th, 1899. Highest.	Lowest
124,400l	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	87 — 92	87 — 92	...	...
905,560l	Anglo-American Telegraph	Stock	£2 13s	3 %	£3 9s	65 — 68	60 — 63 xd	65½	61
3,047,220l	Do. do. 6 % Pref.	Stock	£5 6s	6 %	6 %	118 —119	109 —111 xd	117½	111
3,047,220l	Do. do. Deferred...	Stock	...	...	18s. %	14 — 14½	13 — 13½	14½	13
205,151	Brazilian Submarine Telegraph	10	7 %	7 %	...	15¾— 16¼	15 — 16	15⅞	15
75,000l	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	110 —114	110 —114	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2½— 3	2½— 3	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	8 %	185 —195	185 —195	...	...
1,332,523l	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106	106	105⅝
224,850	Consolidated Telephone Construction and Manufacturing	10/-	2 %	1½ %	...	3/16— 4/16	3/16— 4/16	...	...
16,000	Cuba Telegraph	10	8 %	7 %	8 %	9 — 10	9 — 10	9⅞	9¾
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½— 19½	19 — 20	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11	9½— 10½	...	...
30,000l	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½ %	4½ %	...	106 —109%	106 —109%	...	...
60,710l	Direct United States Cable	20	3 %	3¼ %	...	12 — 12½	10½— 11½	11 1/8	11
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	103 —106	102 —105	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	6½%	7 %	...	177 —182	160 —170 xd	175	160
1,795,000	Do. 3½ % Pref. Stock	100	...	...	...	102 —105	100 —104 xd	103	101
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	...	99 —102	99 —102	...	...
1,432,268l	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	125 —129	125 —129	123	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	18 — 18¼	16 — 17	18 3/16	16
16,200l	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	...	99 —103	99 —103	...	...
64,400l	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	...	100 —103	100 —103	...	...
320,000l	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	125 —129	125 —129	125	...
35,100l	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	...	...	99 —103	99 —103	...	...
46,500l	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	...	...	100 —103	100 —103	...	...
300,000l	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	...	...	102 —105	102 —105	...	...
200,000l	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	...	...	104 —107%	104 —107%	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	5⅛%	12⅜— 13⅛	11½— 12½	12⅞	11⅞
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6⅝%	16¾— 17¼	16 — 17	16⅞	16¾
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	...	30 — 31	30 — 31	...	...
92,600	Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	99 —102	101	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	57 — 60	57 — 60	...	...
100,000l	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	...	108 —111	108 —111	...	...
490,000	National Telephone, 1 to 490,000	5	5½%	6 %	6 %	4½— 5	4½— 5	4 15/16	4¾
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	12	11⅞
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4¾— 5¼	4¾— 5¼	4 15/16	4¾
1,329,471l	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	99 —101	99 —102	100½	99
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅞— 1	⅞— 1	...	...
100,000l	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	...	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 —145	137 —142 xd	...	...
58,000	United River Plate Telephone	5	5 %	6 %	...	4¾— 5¼	4¾— 5¼	5	...
151,733l	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	...	...
200,000l	West African Telegraph, 5 % Debs.	100	5 %	5 %	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	103 —106	103 —106	...	...
389,521	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	106	...
88,321	West India and Panama Telegraph	10	1 %	¾%	...	2 — 2¼	2 — 2¼	2 1/16	2 1/16
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	...	10¾— 11¼	11 — 11½	11 7/16	11
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	...	9 — 10	9 — 10	...	...
80,000l	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	...	105 —108	105 —108	...	...
158,100l	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	6 %	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	6 %	7 %	8 %	10½— 11½	11 — 12	11⅝	11⅜
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	5 %	6 %	6 %	7½— 8½	7½— 8½	8¼	...
100,000	Do. do. do. % Deb. Stock Red....	Stock	4½%	4½%	...	114 —116	114 —116	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000 ...	10	7 %	10 %	6 %	16½— 17½	17½— 18½	18	17
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15 — 16	15 — 16	15 7/16	14⅞
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	124 —129	124 —129	127½	127
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	nil	nil	11 — 12	11 — 12	11¼	10 15/16
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	14 — 15	14 — 15	...	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	5 %	...	5¼— 5⅜	5¼— 5⅜	5⅜	5 5/16
19,661	House-to-House Electric Light Supply, Ord., 101 to 19,661	5	...	4 %	6 %	8¾— 9¼	8¾— 9¼	...	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	...	9 — 10	9 — 10	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	3¾— 4	3¾— 4	3⅞	3 1/16
48,...	Do. do. do. 6 % Pref.	5	...	...	6 %	6½— 7	6½— 7	6⅞	6 9/16
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	105 —107	106 —108	...	...
62,500	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	5 %	17 — 18	17 — 18	17⅝	17¼
22,500	Do. Nos. 62,501 to 85,000, £7 paid ...	10	...	...	...	13 — 14	13 — 14	...	...
220,000l	Do. 4½ % First Mortgage Debenture Stock	...	4½%	4½%	...	117 —120	117 —120	...	...
6,452	Notting Hill Electric Lighting	10	4 %	6 %	6 %	16½— 17½	16½— 17½	...	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	10½%	14½%	14½%	17½— 18½	17½— 18½	17⅝	17⅛
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	...	...
65,000	South London Electricity Supply, Ord., £3 paid	5	...	...	...	3¼— 3½	3¼— 3½	3⅜	3¼
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	9 %	12 %	12 %	15 — 16	15 — 16	15⅝	15 5/16

* Subject to Founder's Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
§ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation April 12th.	Closing Quotation April 19th.	Business done during week ended April 19th, 1899. Highest	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	10 %	10 %	...	3 — 3½	2¾— 3¼	...	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	95 —100	95 —100	...	...
30,000	British Electric Traction	10	...	...	6 %	18¾— 19¼	18½— 19	19⅛	18½
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13¾— 14¼	13¾— 14¼	14 1/16	14
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	126 —129	126 —129	127½	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	*nil*	*nil*	...	1⅞— 2⅛	1⅞— 2⅛	1 15/16	1⅞
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	*nil*	4 %	...	2⅛— 2⅜	2⅛— 2⅜	2⅜	2¼
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	101 —103	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	10 %	12½%	...	12½— 13½	12 — 13	13⅛	12
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	114 —117	114 —117	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	9⅜— 10¼	9⅜— 10¼	10	9⅞
178,303	Do. do. do. £8 paid	10	...	...	...	7⅞— 8¼	7⅞— 8¼	...	...
61,033	Do. do. Pref. half-shares £3 paid ...	...	...	...	...	3½— 4	3½— 4	...	...
71,447	Do. do. Def. do. £5 paid ...	...	...	...	...	4¼— 4⅝	4¼— 4⅝	4½	4 7/16
630,000*l*	City and South London Railway	Stock	1 1/16 %	1⅛%	2⅛%	68 — 70	68 — 70	68	66
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £5 pd.	10	...	...	...	4⅜— 5¼	4⅜— 5¼	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	3¼— 3⅝	3¼— 3¾	...	...
100,000	Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	...	...	...	...	98 —101	98 — 101	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5½%	6 %	...	2 — 2½	2 — 2½	2⅜	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5½%	6 %	...	4 — 5	4 — 5	...	...
344,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	97 — 99	96 — 98	97¼	97
112,100	Electric Construction, 1 to 112,100	2	5 %	6 %	6 %	2⅛— 2⅜	2 — 2⅛	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	3 — 3½	3 — 3½	...	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	103 —106	103 —106	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	⅛— ¾	⅛— ¾	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	⅛— ¾	⅛— ¾	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 12	10 — 12	...	...
15,000	Henley's (W. T.) Telegraph Works, Ord.	10	10 %	12 %	14 %	25½— 26½	24 — 26	25¾	24
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18½— 19½	18½— 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	4½%	...	112 —115	112 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21½— 22½	21½— 22½	22⅛	21 3/16
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	101 —105	101 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	3¼%	3¼%	10 3/16—10 5/16	10 3/16— 10 5/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	14⅜— 14⅝	14⅜— 14⅝	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	35 — 39	34 — 38	36¾	34¾
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	105 —108	105 —108	...	...
13,400	Telegraph Manufacturing, Ord. Nos. 6,601 to 20,000 ...	5	...	...	...	9¾— 10¼	9¾— 10¼	...	...
13,400	Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000	5	...	...	...	5¾— 6¼	5¾— 6¼	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	3 %	109 —112	109 —112	...	...

† Quotations on Liverpool Stock Exchange.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10⅛.
British Aluminium, Ordinary, 10—11; 7 % Pref., 11—12.
House-to-House, 4½% Debentures of £100, 105—108.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 13—13½; 1st Preference Cumulative 6%, £5 (fully paid), 7½—8. Debentures, 107—110. Dividend, 1898, on Ordinary Shares 10%.
National Electric Free Wiring, 10s. paid, ⅜—½.
Smithfield Market Electric, 3—4.
*T. Parker, £10 (fully paid), 16.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (February 2nd, 1899).

MARKET QUOTATIONS, Wednesday, April 19th.

CHEMICALS, &c.	This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a " Nitric .. .. .. per cwt.	22/-	22/-	..
a " Oxalic .. .. .. per cwt.	32/-	32/-	..
a " Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. per cwt.	37/-	37/-	..
a Ammonia, Muriate (grey) .. per ton	£19	£19	..
a " " (white) .. per ton	£26	£26	..
a Bleaching powder .. .. per ton	£5 15	£5 15	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. .. per ton	£16 10	£16 10	..
a Benzole (90 %) .. .. per gal.	7/-	7/-	..
a " (50/90 %) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. per ton	£25 10	£25 10	..
a Lead, Nitrate .. .. per ton	£23 10	£23 10	..
a " White Sugar .. .. per ton	£30 10	£30 10	..
a " Peroxide .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	3½d.	3½d.	..
a " Caustic (75/80 %) .. per ton	£24	£24	..
a " Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. .. per cwt.	68/-	68/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6 15	£6 15	..
a " Recovered .. .. per ton	£5 15	£5 15	..
a " Lump .. .. .. per ton	£5 5	£5 5	..
a Soda, Caustic (white 70 %) .. per ton	£7 10	£7 10	..
a " Crystals .. .. .. per ton	£3	£3	..
a " Bichromate, casks .. per lb.	3d.	3d.	..
METALS, &c.			
b Aluminium Wire, in ton lots .. per ton	£294	£294	..
b " Sheet, in ton lots.. per ton	£191	£191	..
p Babbitt's metal ingots .. .. per ton	£65 to £130	£65 to £130	..
c Brass (rolled metal 3" to 12") basis per lb.	8d.	7¾d.	¼d. inc.
c " Tube (brazed) .. .. per lb.	10½d.	10d.	½d. inc.
" Wire, basis .. .. per lb.	8½d.	8d.	½d. inc.

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d
e

METALS, &c. (*continued*).	This week.	Last week.	Increase or Decrease.
f Ebonite Rod .. .. .. per lb.	3/-	3/-	..
f " Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£80	£80	..
g " Wire (basis price) .. per lb.	9½d.	9½d.	..
g " Sheet .. .. .. per ton	£80	£80	..
g " Rod .. .. .. per ton	£80	£80	..
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	6/-	6/-	..
h India-rubber, Para fine .. per lb.	4/3½	4/3½	¼d. dec.
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i " Pig (Cleveland warrants) per ton	48/1	47/11½	1½d. inc.
i " Forgings, according to size per ton	From £11	From £11	..
i " Scrap, heavy .. .. per ton	50/- to 55/-	50/- to 55/-	..
i " Wire galvanised No. 8 .. per ton	£9 10	£9 7 6	2/6 inc.
g Lead, English Ingot .. .. per ton	£14 12 6	£14 12 6	..
g " " Sheet .. .. per ton	£15 15	£15 10	5s. inc.
l Mica (uncut slabs 6" long) .. per lb.	6/6	6/6	..
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. .. per bottle	£8 5	£8 5	..
p Phosphor Bronze, plain castings per lb.	1/- to 1/4	1/- to 1/4	..
p " rolled bars & rods per lb.	1/- to 1/4	1/- to 1/4	..
p " r'l'd strip & sheet per lb.	From 1/2	From 1/2	..
o Platinum .. .. .. per oz.	£3 10	£3 10	..
p Silicium Bronze Wire .. .. per lb.	10d. to 1/1	10d. to 1/1	..
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£115	£115	..
g " foil .. .. per lb.	1/4	1/6	2d. dec.
n " wire Nos. 1 to 16 .. .. per lb.	1/6	1/6	..
p White Anti-friction Metals— "White Ant" brand .. per ton	£40 to £65	£40 to £65	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	7½d.	7½d.	..
j " Flax, 6 or 8 lea... .. per lb.	4d.	4d.	..
j " Hemp, 3 ply 10 lbs. .. per lb.	3½d.	3½d.	..
j " " Russian, 10 lbs. per lb.	4½d.	4½d.	..
j " Jute, 180 lbs. rove .. per ton	£12	£12	..
j " Manila, 24 thread .. per ton	£33 10	£34 10	£1 dec.
k Zinc, Sheet (Vielle Montagne bnd.) p.t.	£31	£31	..

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Yeo & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
l Messrs. Sanders, Wake & Co.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

INSTITUTION OF ELECTRICAL ENGINEERS.

The Hissing of the Electric Arc. By Mrs. Ayrton. (Read on March 23rd, 1899.)

(*Concluded from page* 616.)

Some curves connecting the P.D. between the carbons with the current when the arc was completely enclosed in the crucible (fig. 8) are given in fig. 9. The carbons were solid, the positive being 11 mm. and the negative 9 mm. in diameter, similar to those used with the open arc experiments (fig. 1). As this crucible—the first one made—had no window, the length of the arc could not be kept quite constant, but the distance by which the carbons were separated was noted at the beginning of the experiment, and they were then allowed to burn away without being moved till the end, when the distance the positive carbon had to be moved in order to bring it tightly against the negative was noted. Measured in this way, the length of the arc was 1·5 mm. at the beginning and 2 mm. at the end of the experiment. The current was started at 6 amperes, and gradually increased to 39 amperes, then as gradually diminished to 6 amperes again, increased to 36 amperes, and diminished to 5 amperes, when the arc was extinguished. The P.D. between the carbons for a given current seems to have increased as the length of nitrogen was used, viz., no change was produced in the P.D. between the carbons unless the pressure of the gaseous stream were large enough to blow the arc on one side, and then an increase and not a diminution in the P.D. was observed.

If, however, the current was *very near* the value that made an open arc of the particular length used start hissing, blowing either nitrogen or carbon dioxide through the positive carbon sometimes started hissing; but this was due, *not* to any direct action of the stream of gas on the carbon, but to the arc being deflected by the gaseous stream and burning obliquely up the side of the carbon, and thus allowing the air to come into contact with the crater. The proof of this was that this diminution in the P.D. had the same value as if air had been employed, and that the hissing phenomena did not disappear on stopping the stream of nitrogen or of carbon dioxide.

This was not the case with hydrogen, however. When that gas was blown down the positive carbon in the open air, the arc would start hissing if the current were large enough, *and stop hissing the moment the hydrogen was shut off*. Not only this, but the diminution in the P.D. had a different value from that produced by air, being only about 6·5 volts instead of 10 volts. Table IV. gives the current and the P.D. between the carbons just before the hydrogen was turned on, just after it was turned on, just before it was turned off, and just after it was turned off.

Arc Enclosed in Crucible.

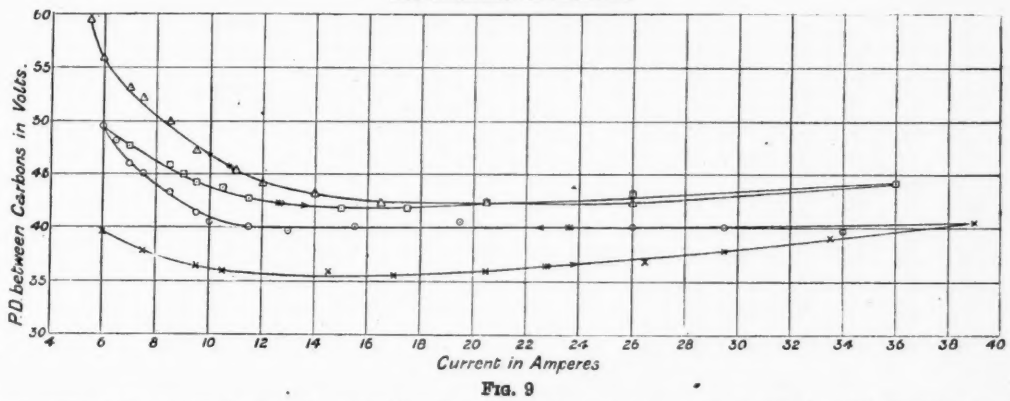


Fig. 9

Curves connecting P.D. and current for nearly constant length of arc of 1·5 mm. to 2 mm. The arrows show the direction in which the current was varied. Carbons.—Positive, 11 mm. solid; negative, 9 mm. solid.

time during which the arc had been burning increased; this was undoubtedly partly due to the lengthening of the arc, but was probably also partly due to the whole of the air in the crucible having been gradually burnt up or driven out through the slag wool and the asbestos ring by the pressure of the carbon vapour.

Many other sets of curves were obtained, but all with the same result, viz., that, when once the crucible had been freed from air, no sudden diminution in the P.D. could be observed on increasing the current far beyond the value at which this diminution occurred on lifting up the lid and allowing the air to have access to the arc.

The next thing to do was to try if an open arc could be made to hiss and the P.D. to suddenly diminish by blowing air at the crater when the current was so small that the crater remained well at the end of the positive carbon—in fact, to bring the air in contact with the crater artificially when a much smaller current was flowing than would usually produce hissing. I first tried inserting a carbon tube in the arc and blowing through it, but this almost invariably blew the arc out. Then Mr. Phillips, one of Prof. Ayrton's assistants at the Central Technical College, suggested using a tubular positive carbon, and blowing the air down it. This plan answered admirably, for when a current of 10 amperes was flowing with an arc of about 3 mm., so that the arc was quite silent, each puff of air blown down through the positive carbon was followed by a hiss and the characteristic diminution of the P.D. between the carbons. With a current of 6 amperes, however, I could get no hiss, but simply blew the arc out each time, probably because, with such a small current, the arc was cooled sufficiently to be extinguished before the action could take place.

Oxygen was next tried, still with the open arc, and again each puff produced a hiss and diminution of the P.D., the latter being exactly the same in amount as when air was used, namely, about 10 volts. As my idea was that the diminution of the P.D. was due to the chemical combination of air with carbon at the temperature of the crater, the fact of oxygen producing the same diminution of the P.D. as air seemed to show that nitrogen would produce no effect, and that all the effect produced by air was due to the oxygen in it. Accordingly I tried blowing nitrogen down the positive carbon of an open arc, and found that *no* change in the P.D. followed if the nitrogen was blown through gently, but that, beyond a certain pressure, the arc was blown to one side, and thus lengthened, so that the P.D. *rose*, and, if the pressure continued, the arc went out.

This experiment proved two things—firstly, that it is the *oxygen* in the air that causes the diminution in the P.D. with hissing; secondly, that this diminution in the P.D. is not due to cooling, for nitrogen would cool the arc as effectually as oxygen or air.

To make assurance doubly sure on this point, carbon dioxide was blown down the tubular positive carbon, with the same result as when

Table IV.—Effect of Blowing Hydrogen down a Tubular Positive Carbon.

Carbons:—Positive, 11 mm. tubed; negative, 9 mm. solid; length of arc, about 3 mm.

P.D. between carbons in volts.				Current in amperes.
Before H. was turned on.	After H. was turned on.	Before H. was turned off.	After H. was turned off.	
52	46	46	53	14
52	45	47	52	12
52	45	45	52·2	12
52·5	46	46	53	12
52	45	46	52	9

Thus, the mean diminution of P.D. accompanying the hissing caused by hydrogen being sent down the positive carbon of an arc burning in the air was about 6·6 volts, or about 3½ volts lower than when the hissing was caused by air alone.

In order to exclude all possibility of doubt as to the effect of the various gases, I repeated the experiments with the arc entirely enclosed, so that the only gases that could reach it were those blown down the tubular positive carbon. The current was distinctly below the hissing point, being only 10 or 11 amperes, and the arc was from 2 mm. to 3 mm. long.

When air was blown down the positive carbon, each puff lowered the P.D. by about 10 volts, and the moment the puff ceased the P.D. rose again. Next, oxygen was tried, with the same result. Thirdly, nitrogen with *no* result, or with the result that the arc was blown out if the pressure was too great. Carbon dioxide had the same effect as nitrogen, and lastly hydrogen was tried.

This gas, however, gave a totally different result with the enclosed arc from that already obtained with the open arc; for whereas, as has been previously stated, hydrogen produced a distinct hissing of its own when blown down the positive carbon in the *open air*, it produced *none* when used in the same way with the *enclosed* arc.

To prove that, in order to produce the sudden diminution of P.D. under discussion it was necessary for the active gas to actually touch the crater, a tubular *negative* carbon was used, and each gas was blown up through it in turn, gently enough not to force the gas directly against the crater.

In *no* case was there any sudden diminution of the P.D., whatever was the gas blown through the negative carbon, and whether the arc

was open or enclosed. On the contrary, there was generally a small increase, probably due to the lengthening of the arc by its being blown on one side. If oxygen or air were blown *very hard* up the negative carbon, they would either produce hissing, or blow the arc out, or both; for in that case some of the gas got to the crater uncombined with the carbon vapour, and acted exactly as if it had been blown down the tubular positive carbon.

The case, then, stands thus:—

1. When the arc begins to hiss in the ordinary way, the P.D. between the carbons diminishes by about 10 volts.

2. If the air is excluded from the arc, this diminution of the P.D. does not take place, even when the current is nearly three times as great as would cause hissing in the air.

3. If, however, while the air is excluded, puffs of air are sent against the crater, the diminution of the P.D. *does* occur, even with currents much *smaller* than would cause hissing in the air.

4. If, instead of air, *oxygen* is sent against the crater, the P.D. is diminished to exactly the same extent as when air is used.

5. If, on the other hand, *nitrogen* is sent against the crater, *no* diminution of the P.D. is observable.

6. If air or oxygen is gently blown through the *negative* carbon, so that it cannot get direct to the crater, *no* diminution of the P.D. follows.

Thus there can be no shadow of doubt that the sudden diminution of P.D. that accompanies the hissing of the open arc is due to the oxygen in the air getting directly at the crater and combining with the carbon at its surface.

This explanation, like many another in science, solves certain difficulties, only to create others which may, perhaps, be yet harder to deal with. Directly we know exactly how the diminution of P.D. accompanying hissing is brought about, we ask, "How does this combination of gas and carbon, at the temperature of the crater, act in producing a diminution of P.D. so sudden, so certain, following such definite laws as those we have been considering? Why do certain gases produce it and not others? Why does hydrogen act in the presence of air, but not when air is absent?" &c.

These are questions that have been occupying me for some time past, and which will, I hope, be completely answered by the series of experiments on which I am still engaged. These latter experiments, although suggested by the investigation on the hissing of the electric arc, have already opened up a different field of inquiry, and the further results may therefore with advantage be reserved for a future communication.

It only remains for me to express my high sense of the honour done me by the Institution of Electrical Engineers in asking me to read this paper, and to thank the many people to whom I am indebted for very kind assistance.

My most sincere thanks are due to Prof. Ayrton for much criticism, for advice as to the methods of conducting the experiments, and for invaluable help in the literary portion of the work, to Mr. Solomon for constructing with much ingenuity the first enclosing crucible, and for making the earlier experiments with it; to Mr. Phillips for assisting in the experiments and for drawing most of the diagrams, especially the admirably-executed coloured drawings of the hissing and silent arcs; to Mr. Carter for supervising, and to Messrs. Manuel and Pletts for very carefully constructing the apparatus for the experiments of this evening; and, lastly, to Messrs. Arundel and Spencer for helping with most of the experiments for the paper, and for conducting many of them alone, with great skill and patience, as well as for carrying out all those that have been shown to you this evening.

ECONOMISERS.

There are some correct remarks on economisers in the *Engineering Times*, the latest issue of which is more technical and less popular than earlier numbers. As stated, there is more to be gained by the use of the economiser with high pressure boilers than with low pressure, because, though the total heat in the steam produced in the boiler may be very little different in the two cases, the water temperature is much higher, and the gases escape much hotter to the economiser, and there is more heat to be absorbed. Even where the economy in fuel is not of such serious importance there is the economy in boilers. With hot feed from an economiser the damage to boilers will be much reduced. This is particularly the case with boilers at a high pressure, and therefore also at a high temperature.

Our contemporary does not believe in the use of the return ¾-pipe to introduce hot water in the economiser feed in order to prevent sweating. It would be preferable to heat the economiser feed by means of an exhaust feed heater as the ¾-pipe will sometimes fail. Quite so! But while we admit the superiority of the suggested method, if a ¾-pipe fails, possibly a 1-inch pipe will not. The intention is simply to heat up the lower ends of the pipes and the bottom boxes until they cease to condense out the moisture of the furnace gases. A better system in large installations is to place the economiser in sections and pass the water through the sections in series. This safeguards at least the later sections, and if sweating should occur it will be concentrated on the first section and upon a greater area of this. The net result will be to destroy, say, one pipe over all its length in place of destroying in the same time, it may be three, four, or even six pipes over a sixth of their length which means ruin just as much as if the whole length had been corroded. But there need be no external corrosion if proper management is followed. Brass pipes have been tried and failed entirely because of this external corrosion. With present high pressures the care necessary in making a cast-iron pipe is very great. Our contemporary says nothing on this point. Why cannot wrought-iron pipes be employed? Because the external corrosion would be far more rapid than with cast-iron. But, given proper arrangements so as to avoid the sweating action, and there should be no objection to the use of wrought-iron or mild steel tubes for high pressure economisers. Tubes are dearer, of course, than if cast, but by no means seriously so, and a well kept and cared for economiser of steel pipes should be far safer than one of cast-iron, and would be safer against accident from a gas explosion in the flues. There can be little doubt that certain economiser explosions were due to gas accumulations. In this respect we would always advise that there should be an air inlet damper to the main flue, which should be opened whenever banked up quiescent fires are to be broken up. By opening the air inlet and then the chimney damper, and keeping the boiler dampers closed, the flue through the economiser could be cleared of its accumulated gas before the boiler fires were livened up, and a length of air would be placed between possibly explosive gases and the newly livened flames. Economisers do undoubtedly prevent much incrustation in the boiler, and require occasionally to be bored out. Special appliances are used for this, which bore out several tubes at once. We fully believe that economisers are a good investment, saving not merely a considerable percentage of coal, but much wear and tear of boilers. They have been neglected by electrical engineers, probably because a good deal of American influence has been brought to bear on electrical station design, and non-condensing engines and no feed heating are the salient characteristics. True, these features are rather those which characterise the work of electrical contractors who have erected stations as quickly as possible which would perform a certain amount of work irrespective of economy. But such work is very much looked down upon by economical and experienced steam engineers who are accustomed to look to fine fractions in economy. It seems ridiculous to strive for the economy of high pressure steam plant, which is not so very much better than more easily maintained lower pressure plant, and to neglect an easy 10 per cent., or even 15 per cent. to be secured by a hot feed.

MACHINE SHOP MANAGEMENT IN EUROPE AND AMERICA.

Continuing his articles in the *Engineering Magazine*, Mr. H. F. L. Orcutt is particularly interesting as disclosing the mental attitude of a commercial American who has to a large extent abandoned the usual American attitude of everlasting superiority. Mr. Orcutt lives in Europe and, preferably, when he can, in England. He finds a freedom in England denied him in America and in Germany. But he cannot quite shake off his early training, and makes many statements which facts do not, we think, bear out. Taxation, which as income-tax no doubt hits him directly, causes him to overrate English taxation and underrate that of America. He is not correct, we feel very sure, when he claims for American mechanics higher nutrition than the English mechanic can purchase. Mr. Orcutt cannot be familiar with the high wages paid in English shops. He also overrates the average amount of education enjoyed by American children. The common school of America is not the equal of the English Board School. But is he right when he says that the American child mixes with the children of social superiors? This is, to some extent, true; but it is only a partial truth, and it is untrue in the large cities. The poorer classes are crowded into districts, and actually the schools are much as here in respect of the results so obtained, for children in these districts go to the district school and are separated from the better class schools by this very fact. Mr. Orcutt throws very grave doubts on the much-lauded technical education of Germany. He should know, for he lives there. The highly educated German works out his clever theory and gets out his elaborate drawing and there he stops. He goes not into the actual construction, but leaves it to an inferior being altogether, on whom he looks down with contempt. All Germany, according to Mr. Orcutt is busy in gazing contemptuously upon the social grade next below it. Mr. Orcutt sees very largely the purely American or dollar side of a question, and cannot understand any man accepting any less pay for the sake of a better (socially) position. But a better position in Germany appears to comprise chiefly the above ability to despise former associates. American engineers are democratic in their work, but, regrets our author, are not so politically. We doubt the higher purchasing power of an hour's work in America, because we find men work longer hours to secure, in cities at least, an inferior living to that afforded in England. We have failed to find in America the refinements of life and comforts which are claimed, nor is food cheaper there than in England. And what there is tends to coarseness when abundant. We fully believe that the superiority of American mechanical labour in respect of its greater output is chiefly due to better organisation and the use of labour-saving appliances. This latter is largely a question of the influence of trades unions, and it is to their chilling influence and deliberate damping of a worker's powers in England that we find American products now coming forward so plentifully. Mr. Orcutt doubts if the Germans realise their loss due to militarism. He thinks but little of the discipline it secures for the crushing effect of too much hard discipline outweighs the benefit it may confer on organisation. "Senseless, bureaucratic ideas" is his expression for the all pervading effect of militarism. Do we not have our own War Office? Nor is the German workman so thorough as the Englishman we are told. This is not saying too much for the German if the Englishman is not, as a rule, much better than most members of the A.S.E. who were out on the late strike.

At the same time, Mr. Orcutt overrates the American apprentice

and his training. We do not think he does get the all round training claimed for him. He is a first-rate mechanic on fine work with a good special tool, and is, in fact, a specialist. But America is largely recruited from Europe for better class mechanics of all-round ability. Of German technical education we are asked to be suspicious. The German, as above stated, lacks the spirit of practical investigation, and leaves this to the uneducated, which is just what he should not do.

Social rot is the term used to designate the effect of England's support of trades unionism, although the benefits are recognised which have been conferred on women and children by protective legislation. Now, we say boldly curselves, that if the workers, the men of Great Britain would, as a mass, change about the ratio spent on their wives and children, and the amount spent on the publican, there would be no need for protective legislation. Working men's wives need not work but for the craving for unlimited beer which pervades the men.

We do not wish to bind men down to a narrow teetotalism, but we are assured by our experience that the curse of drink is at the bottom of all England's industrial troubles. There is no country in the world with our resources, climate, physical energy, brains and general capacity, and it is all discounted by drink. Shop work is delayed by the Monday holiday, and the general depreciation the week through of the men's energies. The drink idea pervades all classes up to many works' managers and proprietors, and even sober men are unable to keep a ship afloat when the drunken first mate is helping the equally drunken partner to bore holes in the ships' bottom. Mr. Orcutt and all the political economists may write pages and pages on the reasons for American success. In plain words America is successful because Germany is overloaded and crippled by her silly social prejudices and militarism, England by her inebriate workers, and so America, which has the English virtue of being non-military and drinks sober German beer, gets the better of both nations.

SCHUCKERT & CO.

Whether we are to ascribe it to their admirable system of technical education, or to some other cause or combination of causes, it is an undoubted fact that Germany has played a leading part in the modern development of electrical engineering. No better evidence could be found of this than the remarkable rise from small beginnings of some of the great electrical manufacturing companies of which our Teutonic neighbours can boast. About a year ago we gave a short account of the development of Siemens & Halske (Electrical Review, 41, p. 813) on the occasion of their 50 years' jubilee, and now we propose to give some account of the history of another large company, whose full title is the Elektrizitäts-Aktiengesellschaft vormals Schuckert & Co. These notes are derived from an elegantly got up and illustrated book published by the company on the occasion of its 25 years' jubilee.

Johann Sigmund Schuckert, the founder of this company, cannot be set down as the product of any superior system of technical education; his career reminds us rather of that of our own industrial heroes as immortalised in the pages of Smiles; individual initiative and self-help having been apparently the most striking characteristics of his early life. Born at Nürnberg in 1846, he entered as an apprentice, at the age of 13, the workshops of Frederick Heller. He showed extraordinary talent for engineering, and distinguished himself by constructing at that early date a model of an electric railway. As journeyman (in the literal sense of the word) he gained practical experience in some of the best workshops in Germany, working for short periods at Stuttgart, Hanover, Berlin (with Siemens & Halske), and at several other places. When later he returned to his native Nürnberg, he got the appointment of foreman at Krage's Telegraph Construction Works. During this time he studied technical literature and taught himself English. Thus equipped, he went to America, where he worked in the workshops of Edison and many other electric engineers. We may take it, therefore, to our credit, that Schuckert owed something of his practical engineering ability to the Anglo-Saxon race.

In 1873 Schuckert returned to Europe with the object of visiting the Vienna Exhibition, but at that time he fully intended to return to the United States and to settle there, but his friends in Germany induced him to abandon this resolution and settle in Nürnberg. Here, then, in his native town, he started, in August, 1873, a small workshop in which he worked for some months without any assistants. From this small beginning grew the great manufacturing company whose principal establishments at Nürnberg and Berlin, and smaller branch establishments employ at the present time more than 7,000 workmen.

It was not till 1874 that Schuckert entered seriously on the construction of electrical machinery. At that date he successfully constructed a hand driven dynamo in spite of predictions of failure from a friendly science teacher. About the same date he built a dynamo for electro-deposition which did its duty for 18 years till it was acquired by the employés of the firm to be placed in the works' museum.

In 1875 Schuckert constructed his first dynamo for lighting. From this time he devoted himself to the improvement of the dynamo, replacing the Gramme ring by the flat ring. His works were enlarged in 1878 though at that time he had only 12 assistants and three apprentices. A few years afterwards Waeker, of Leipzig, was taken into the firm as business manager with the happiest results.

With most of the subsequent developments of electrical engineering the name of Schuckert was identified. In 1879 and 1880 he succeeded in running arc lamps in series, improved the Krizik lamp, and installed the first continuous arc installation in Germany, by lighting the machinery hall at the Leipzig Exhibition.

Having seen the Edison glow lamp at Paris, he took it up and soon after was fitting up combined arc and glow lamp installations. In 1882 instrument making was taken up, and in 1883 electric traction and search lights. A great advance was made in the construction of the projectors for search lights by the adoption of Prof. Munker's apparatus for grinding parabolic mirrors. The Schuckert search light had an improved axial arrangement of carbons and prisms to convert the concentrated light into diffuse light; it was shown at the Chicago Exhibition, and is used on the lighthouse at Sandy Hook.

Towards the end of the eighties, power transmission began to assume considerable importance in the business of the firm. To-day, two-thirds of the dynamos made by the firm are for this purpose.

In 1887 the first city lighting installation was carried out at Lübeck. This was followed by the lighting of Hamburg, Bremen, Hanover, and Düsseldorf. In 11 years 120 such installations were carried out by the firm. On account of this great increase of business the firm was in 1888 converted into a joint stock company.

Attacked by a nervous disease in 1892, Schuckert retired from the business in 1893, and, after much suffering, he died in 1895.

The company continued to progress; accumulators for central stations, transformers and motor generators for power transmission being some of the important advances with which it was associated. The electro-chemical industry also received their attention and many important works were installed.

We congratulate the company on its position at its 25-year jubilee; the phenomenally rapid development of Schuckert & Co. and its causes deserve the careful study of those interested in the development of our national industries.

THE NICLAUSSE WATER-TUBE BOILER.

The Niclausse boiler formed the subject of a very optimistic paper before the Institution of Naval Architects at the hands of Mr. Mark Robinson. It differs from the usual type of water-tube boiler in having its tubes constructed on the Field principle, the supply of water to those tubes, which are exposed to the fire heat, being given through internal tubes—a system which was found very effective where the tubes were disposed vertically. In this respect the Niclausse boiler has some advantage over others. The tubes are fixed at one end only, and the other end is free to move. To effect this the front header is necessarily double, the main or external tubes being fixed in the rear part of the header. The front division is thus the down comer and the rear division is the rising header; the inner tubes extending, of course, to the front. The inclination of the tubes is flat, somewhat as in the Belleville boiler, of unfortunate experience, and, we confess, we do not like such flat inclinations.

The external tube is closed at one end, and at the other it is screwed by a fine thread into a malleable head or lantern on which are turned two coned portions which fit tightly in the front and back parts of the header, and a central flange which fits easily in the central division. All the various points to which the author wished to draw special attention were first alluded to as at first almost incredible or impossible to be made good and lasting, and then came the antithesis of absolute perfection. Marvellous! is it not? after the manner of a clever conjuror. One of these doubtful points was the securing of the tubes by means of the two cones in two divisions of the header. To Mr. Robinson, who is going to sell the Niclausse boiler in England, and is also going to make it, this ought not to present so very terrifying a prospect. We think the use of suitable tools to turn and bore or grind these tapers ought not to be found a difficulty at the works of Messrs. Willans & Robinson. But we think Mr. Robinson's terrifying attitudes are, after all, like the familiar terrifying attitudes of certain caterpillars, not very fearsome, but still strange and a little theatrical in a description of a piece of mechanical work. Exactly the same attitude is taken in drawing attention to the fact that the furnace gases only make one pass between the tubes despite which the results are good. Now, there is no need to apologise for this single pass, even though other water-tube boilers may have a double or even a treble passage. This boiler has tubes about 7 feet long, and the grate is of the same length, and there cannot be conveniently made more than one passage of the gases. But where is the use of it? We find that the grate surface of one of these boilers is 45·75 square feet, and the heating surface is 1,340 feet. The ratio is thus the very usual one of 1 : 30, or nearly so, from which it follows that the furnace gases were travelled over the usual proportion of heat absorbing surface, and the results ought not to require special remark. If the heating surface had been only 10 times the grate surface, and the gases had passed three times between the tubes some notice would have been warranted had the result been good.

The advantage of the Niclausse boiler is that the tubes can be entirely removed from the front. This is an excellent feature and ought to present no difficulty at the coned joint if these are put together with graphite grease. Coned joints have been used by thousands on fuel economisers for years and need no apology. Trials made of a boiler brought over from France show an evaporation of from 9·59 to 11·23 lbs. per pound of coal from and at 212°, the larger rate being with the low rate of combustion of 12·94 lbs. per square foot of grate. Priming is stated as being so small as to be quite negligible, but no good reasons are advanced for this statement.

Two systems of testing the dryness factor were employed, the salt and the calorimeter. Without quarrelling with either method we

should wish to know how the samples of steam were drawn from the boiler or the steam pipe. Steam sampling is so absolutely valueless as usually carried on—in fact, there is no recognised correct method of drawing a sample—that we cannot accept any figures of dryness as even approximately correct.

For the slow combustion rates of Messrs. Unwin & Kennedy's tests, viz., 13½ lbs., the boiler appears to be about right, rejecting its gases at 512° F., but at moderate rates of consumption it rejects gases at 732° F., and should therefore be assisted by an economiser.

Some figures are given relative to the French cruiser *Friant*. This vessel has 20 boilers weighing, with casings and firebrick linings, 200 tons, or with their uptakes and water, 256 tons. This does not include the chimneys. The weight named is thus only a third of a ton per square foot of grate. There are four boilers of large size having 12 headers and 216 tubes each. The outside diameter of the tubes is 3·22 inches. The tubes are 88½ inches long, the grate is 6 feet 6½ inches long and 45·75 square feet area. The heating surface is 1,340 feet. The smaller boilers have only 10 headers. The total grate area is 775 feet and the heating surface 23,200 feet. A four hours' trial gave 9,438 I.H.P. at a combustion of 25 lbs., and the coal per I.H.P. was 2 lbs. per hour. A number of figures are given, but unfortunately there is not a word as to coal. Hence the absolute uselessness of the remark that there was no flame in the funnels. One does not expect to see flame on the chimney side of a close nest of cold tubes. Another remark is equally useless, that the trials were made without auxiliary air above the grates. Again we ask what coal was used, because if it was bituminous coal the non-admission was an error, and if non-bituminous no air was probably required. We are not quite certain of the matter, but was it not the French cruiser, *Friant*, on which a tube in a boiler split open and caused the death of several men? If so, it would appear that the Niclausse boiler should certainly have solid drawn tubes. The flat inclination of the Belleville tubes has apparently already proved itself wrong, and great care should be exercised with all such boilers. The flatness of inclination is tempting to the designer, who feels compelled to design his boiler either to be of moderate height or to be able to claim a large heating surface in a total small capacity.

We do not understand the author when he claims for his boiler freedom from deposit of lime salts as though this were a quality of the boiler and not of the water. If the water contains lime it will be deposited, some of it in the receptacle in the drum, but if this special receptacle be removed as described, any absence of the expected amount of deposit can only be due to the water being good or the evaporation of the boiler being small. But the reader is, if non-technical, induced to believe that incrustation is a quality of a boiler, not of the water fed into it. Altogether this is a special pleader for the Niclausse boiler, but there is too much pleading in it, so much, indeed, as to throw doubts on some of the claims, especially as so much is put forward which is useless to the technical reader and misleading to the non-technical. Only a day before this writing a boiler maker complained to us that a consulting engineer had called for tenders for a certain size of Lancashire boiler and had asked the makers to give a guarantee of a certain evaporation, as though evaporation could be determined by the use of a certain make of steel plate or by some variation in the pitch of the rivets or the diameter of the safety valve. There is far too much of this kind of thing. One steam boiler is very much as another one once it has got up steam and is reasonably fitted. All engineers know this, yet boiler records are being continually published. It would be more interesting to know how the Niclausse boiler behaved with smoky coal and with forced draught. How much safer is it than the Belleville with both ends of the tubes fixed; what is the improvement in this respect of the compound tubes. Tables of performance in evaporation are useless. Let the grate surface and the combustion rate be given, and the rest may be known. It is a little curious to observe that when a boiler is to be proved good the rate of combustion is so usually found as 13 lbs. In the tests of Messrs. Unwin & Kennedy this is about the rate selected, the test at the higher rate being hardly referred to. Unfortunately, the illustrations accompanying the description show very little of the general arrangement of the upper drum, so one cannot learn to what extent the down comer has been arranged not to draw from the extreme bottom of the drum which should serve as a collector of deposit. The Niclausse boiler is compact, it appears well made, the tube arrangement is rational, and we feel sure that, made by Willans & Robinson, it will be perfect in the mechanical workmanship, but we do not like its tube inclination. Perhaps, however, these boilers are intended for stationary purposes only.

THE ELECTROLYTIC DETERMINATION OF LEAD.

A method for determining the lead in alloys and commercial metals has recently been worked out by A. Hollard, who describes the necessary procedure in the *Bulletin de la Société Chimique*, Vol. xix. (22), p. 911. A method which is electrolytic will probably interest many of our readers. If the details worked out by the author be attended to, lead can be easily and accurately determined as peroxide. Not more than 0·2 gramme of the metal should be present. The operation is conducted in a beaker of about 400 cc. capacity, in the upper part of which, during the solution of the metal or alloy, a funnel rests. The cathode is a flat platinum spiral, the anode a truncated cone of platinum, the upper diameter of which is 18 mm., the lower diameter 45 mm., and the height along the cone 63 mm.; the lower edge of this is fixed about 6 mm. above the spiral cathode. The surface of the anode should be roughened by immersion for some hours in aqua regia.

Lead.—The metal is dissolved in 80 cc. of ordinary strong nitric acid diluted to 350 cc., and the solution electrolysed at the ordinary temperature by a current of 0·15 ampere. The cone must dip completely under the liquid, and the spiral should be close to the bottom of the vessel. The operation is over in 24 hours, when the cone is washed by being plunged successively into two vessels of distilled water and dried in an air-bath, the temperature of which is gradually raised to 200° C., and maintained at that temperature for a quarter of an hour. The attainment of this temperature is essential, otherwise the deposit has not necessarily the composition PbO.

Lead in Commercial Zinc.—Dissolve 10—20 grammes, according to the purity of the metal, in such a quantity of nitric acid (allow 3·5 cc. of ordinary strong acid for the solution of each gramme of zinc) that the solution shall contain at the end 80 cc. of the strong acid; then proceed exactly as above. The removal of the lead in this way makes it easier to determine in the same sample the other impurities of the metal, especially the cadmium.

Lead in Tin-Lead Alloys and Commercial Tin.—If the alloy contains more than 4 per cent. of lead, it is treated exactly as for pure lead (the alloy should be very finely divided), allowing 2 cc. of strong acid for each gramme of tin oxidised. After solution, the whole is warmed to 90° C., till the stannic oxide collects at the bottom; it is then allowed to cool, and the electrolysis begun without removing the tin. If the alloy contains less than 4 per cent. of lead, 5 grammes are attacked in a beaker of a litre capacity by 260 cc. of strong nitric acid, and the whole is diluted to 650 cc. Under these circumstances the oxide of tin collects and settles on heating to 90° C. without taking down lead out of the solutions or forming a protective coating round particles of the alloy. After cooling electrolysis is carried on as above. The same treatment is applied to commercial tin.

Lead in Lead-Antimony Alloys and Commercial Antimony.—The method cannot be applied. The anode deposit always contains antimony oxide.

Lead in Commercial Copper and its Alloys.—The sample must contain at least 1 gramme of copper. The amount of acid must be such as to leave free (1 gramme of copper needs 3·6 cc. of strong acid) 14 cc. of strong acid at the end. The whole is diluted to 350 cc., and a current of 0·3 ampere passed for 18 hours. If lead be present in very small quantity, 10 grammes of the metal are taken for analysis.

BIRDS OF PREY, BRUSH DISCHARGES, AND OTHER THINGS.

Loughborough is in Leicestershire, and is famous for old pavements, ancient lights, about to be replaced by the light of the age, hosiery, the Brush Electrical Engineering Company's Works, and the Falcon Engineering Society. The latter is the off-pring of the former, and on Friday evening last its members, supplemented by a number of friends, under the presidency of Mr. R. Percy Sellon, enjoyed their annual dinner at the Bull Hotel.

The repast put before them would have done justice to Mr. Bryan's dollar dinner, but the peregrines, hobbies, and merlins, unlike the larger and more rapacious spread eagles in New York, dined wisely, not too well. They were, moreover, spared the deadly after consequences of unlimited half pints of American champagne.

Mr. W. M. Mordey, who proposed the toast of "The Society," amused his audience with a facetious preliminary canter; then, going stronger, he alluded to the engineering future of this country, with special regard to electric traction, and he astonished his hearers by telling them that one power station in New York contained engine power to the extent of one-third of the combined public and private stations in England; then, finishing with a rush, he gave the youthful members the following good advice:—"Always represent yourselves to be under-paid, become thorough workmen, and every week read through, from cover to cover, a good technical paper."

Then, in reply, followed one of "Hansard's Debates."

Mr. Burder, a resident of Loughborough, in proposing the toast of "The Brush Company," led us to understand that the Queen of Sheba, in one of her country rambles in olden times, asked a boy of the town for what Solomon was remarkable, and the boy replied:—"For wisdom, 300 wives, and 600 porcupines." We believe the officials of the Brush Company only lay claim, with perfect propriety, as we shall show later, to the first of Solomon's belongings.

Mr. Sellon told us that 10 years ago, when the Brush Company took over the Falcon Engineering Works, the hands numbered 250, and the wages amounted to £15,000 per annum; in the year of grace 1899, there are over 1,000 employés, and the wages bill totals up to the respectable figure of £75,000 for the 12 months.

He thoroughly believed in the future of the company, which, as he described it, is of no water melon growth; they have two very large and important contracts for electric railways in London, and they were in the position of being able not only to manufacture the electrical part of the plant, but the rolling stock too.

Mr. Sellon gave also thoughtful references to American and trade rival competition and labour disputes, and good-humouredly likened municipal engineers to porcupines, so far as their prickly propensities went.

Mr. Hodgkin, works' manager, toasted "The Visitors," and the Mayor of Loughborough and Mr. G. C. Sillar responded. The toast list was completed by Mr. F. E. Andrews proposing, in felicitous and affectionate terms, the health of "The Chairman," and during the evening Messrs. Watson, Kidner, Hazlehurst, and Cotton showed us that the students were not wanting in that vocal and humorous ability which has given to the world the de Reszkes and Chevaliers of the present day. A most pleasant evening was spent, and the company separated at the early and highly respectable hour of 11 o'clock. The enforced absence through illness of Mr. Raworth, the true guide, philosopher and friend of the birds of prey, was the one source of regret, shared by young and old alike.

Here it may not be inappropriate to give a few particulars of the works, through every department of which we were taken, under the guidance of Mr. Sellon. On the occasion of our visit the weather was atrocious, and the works, at a casual glance, seemed to be composed of mud, new bricks, shavings, and floor boards; but when once inside, we were highly gratified with both the mechanical and electrical departments of the factory, and the excellent display of machine tools.

The Brush Company propose to give the Press an opportunity this summer, when the present buildings are completed, of giving a full illustrated description of the Falcon Works. Meantime the following notes descriptive of the scheme of the shops may be of interest.

Broadly speaking, the Brush Company's manufacturing operations, which are now concentrated at Loughborough, fall under three heads—

1. Dynamo machinery and its adjuncts for light, power, and traction.
2. Vertical steam engines and locomotives.
3. Rolling stock for light railways and electric and other means of traction.

The works already cover an area of some seven acres, and their steady growth may be judged by the fact that they now employ just over 1,000 men, against some 250 men at the time the Brush Company purchased the works from the Falcon Engine and Car Works Company in 1889, which company was then exclusively engaged in the manufacture of steam locos. and railway and tramway rolling stock.

The Brush Company, foreseeing the inevitable advent of electric traction in due course, have maintained this element of the business in existence, and with the nearer approach of electric traction in this country, have made, and are still making, extensive additions to the shops allocated to this branch of work.

As regards the dynamo branch of the business, the company have again enlarged and are enlarging their shops to cope with the construction of the large units of direct current, polyphase and alternating plant which are coming increasingly into demand for traction and power distribution. In particular may be mentioned a special shop for the construction of traction motors and accessories, which has been erected and equipped on the most modern lines with English and American labour-saving appliances, so as to insure uniformity, high quality, interchangeability, and economy of manufacture.

The steam engine business is chiefly composed of the manufacture of the Raworth Universal vertical steam engines, which are being made in all sizes from 25 to 1,000 horse-power, and under equally favourable conditions as are those of the electric traction appliances.

The works are very busy in all three branches of manufacture, and the company has placed itself in the unique position, so far as electric traction is concerned, that it can deliver out of its shops not only combined steam dynamos required for the generating station, but electric tramcars completely equipped, from the motor to the truck and car body, all of the company's manufacture, ready to be dropped on to the customer's rails and start away from the moment of delivery.

The design and equipment of the new shops, and the reconstruction of the old departments has been carefully thought out and only determined upon after the fullest inquiry and the visit of the company's general manager and works' manager to the best and most modern establishments in Europe and America. The company have not hesitated to introduce American and Continental tools where they have felt it would enable their manufactures to compete favourably in the market, while they have adopted methods for the organisation of their supervision and staff, and of labour methods, which are in harmony with the best foreign practice and in advance of most engineering workshops in this country.

Mr. C. E. Hodgkin is the works' manager; Mr. F. E. Andrews, works' secretary, and Mr. A. G. Hansard, works' electrician—a worthy trio to whom we desire to express our thanks for various kindly and considerate attentions.

GERMAN FIELD TELEGRAPH PEACE ESTABLISHMENT.

[COMMUNICATED.]

Since August 3rd of 1893, the peace establishment of the German army consisted of 479,299 privates, not including about 10,000 one-year volunteers. Germany, however, in consequence of her geographical position being more threatened by belligerent neighbours than any other country in Europe, and, above all, France and European-Russia combined having increased their yearly contingency of recruits to 550,000, as compared with only 227,000 in Germany, it became a necessity for the latter to strengthen her Army. This alternative has now been accepted by the German Confederacy, and on March 16th the Parliament decreed that the peace establishment of the Army will gradually be increased, beginning with October 1st, 1899, so as to reach at the end of the year 1903 the number of 495,500 privates. These will be divided as follows:—

Infantry	625	battalions.
Cavalry, including Chasseurs ...	482	"
Field artillery	574	"
Foot artillery	38	"
Engineers	26	"
Communication troop	11	"
Army Service Corps	23	"

The entire forces to be divided into 23 Army Corps.

The "communication troop" comprises the railway brigade, the aeronautical section, and the field telegraph troops. The two former existed already before this new Act of Parliament, whereas the peace formation of telegraph troops is quite new. These three branches being of a kindred service, they will be placed under the same inspectorate, by which they remain in direct contact with the great general staff of the Army.

Even as far back as the year 1879, comparison had been drawn between the English and the German field telegraph organisation, pointing out that the former had a sound body, but no head, whereas the other had a recognised head, but no body. This was actually so, and the consequences of these shortcomings did not fail to show themselves in England by a want of cohesion on the part of the Chatham Telegraph School, the Aldershot Telegraph Troop, and the Postal Telegraph Royal Engineers' companies, with their Horse Guards' staff superior, thus creating undesirable friction and shortcomings at mobilisations and otherwise. The consequences on the German side could have been worse, as Germany was the only military power in the world not possessing a peace establishment for an army telegraph. The Parliamentary proposals confess this danger by admitting that "The formation of special field telegraph troops can no longer be retarded. With the growth of army masses, their guidance becomes unmanageable without the aid of telegraphic communication, and the establishing, maintaining, and attending of such requires a thoroughly efficient *personnel*, which must be exclusively instructed for this service, and which, at

present, does not exist. The military organisation is compelled, in view of the increased importance of field communication, to accept for her own use the highest possible demands."

Military telegraphy was hitherto carried on in Germany by the Royal Engineers as a secondary service, to which each battalion designated a few men who could only pay a limited attention to telegraphy. Such insufficiently prepared troops had, in time of war, to be formed, with others, into telegraph sections for Army Corps and Divisions. Each of these sections consisted of a Telegraph detachment and an Army Service column, the former being composed of three Engineer officers, about 90 Royal Engineers, and from 7 to 11 employés of the Postal Telegraph Service. That such a heterogeneous formation, which did not even exist in time of peace, would not answer satisfactorily all the manifold demands of a thorough field telegraph service was only too evident. Economical considerations, however, prevented the army adopting long ago a more satisfactory system, and the inspectorate of military telegraphs, this head of a nearly bodyless formation, had to do its best to attain the greatest possible efficiency within the narrow lines prescribed. All that could be done was to increase the number of telegraph sections of the war establishment, and to let them participate at the yearly army manœuvres.

A military telegraph school was also established at Berlin in 1887, which yearly received for instruction—from the cavalry, 20 officers and 83 sergeants and capitulators, and from the Royal Engineers 15 officers and 130 sergeants and privates. The Cavalry Telegraph, independent of the Field Telegraph Corps, has charge of the reconnoitering service within the advanced zone of outposts. With this school was also aggregated, as an experimental field telegraph troop, the 5th company of the R.E. Guards and a detachment of the Army Service Corps, with 40 horses for carriages and riding.

Not only the *personnel* but also the material was considerably improved under the old organisation, in spite of its experimental character. In this respect English as well as German field telegraphs obtained great furtherance from adapting the "vibrator" and "light field cables." The sensitiveness of the former allows the telegraph to be worked with weak currents, and over lines with even very faulty insulation. Besides that, this apparatus is easily adjusted and of small weight. The light field cables, on the other hand, are not only mechanically stronger, and therefore more reliable than any of the older types, but they considerably reduce the weight of the cable line material, so that the telegraph can now with certainty keep pace with an advancing army. The lighter cable and more movable columns enable the field telegraph to operate closer to the enemy as was formerly the case, so that not only the headquarters of army corps and divisions can now be connected to the base of operations, but also brigades and detached forces can be included into the network of telegraphic communication in the field.

The experimental field telegraph section of the 5th Company of the R.E. Guards connected with the Berlin military telegraph school, having since the year 1896 been relieved of the many other duties of military engineering, received, besides a general military drill, an exclusively telegraphic instruction. This troop soon attained a high efficiency, so that the new organisation could then be decided upon such satisfactory result. This experimental 5th Company of the Guards will now form the stem of the new corps. The new field telegraph peace establishment will consist of an inspectorate and three field telegraph battalions of, together, 10 companies, and of the following complement: 49 officers, 7 surgeons, 3 paymasters, 166 sergeants, including paymaster assistants, artificers, musicians and hospital assistants, besides 1,339 privates, showing an establishment of 1,566 officers, non-commissioned officers and men. To this have to be added three battalions of the Army Service Corps, with full complement of men and horses for the carriage equipment, consisting of 3 officers, 12 non-commissioned officers, 105 men, and 144 horses. Besides these a fourth detachment of the Army Service Corps will remain with the Cavalry Telegraph School at Berlin, consisting of 12 privates and 25 horses. The total of the Army Service Corps thus to be: 3 officers, 129 non-commissioned officers and men, with 169 horses, giving a great total for the peace establishment of the new German Field Telegraph Corps of 1,698 officers, non-commissioned officers and men, with 169 horses. The formation of these troops will likewise begin with October 1st of this year.

REVIEW.

Continuous Current Dynamos in Theory and Practice. By J. Fisher-Hinnen. Biggs & Co., Fleet Street, E.C.

This work deals principally with machines constructed on the Continent, and is based on the author's practical experience as designer of dynamos at the works of Messrs. Farcot and at Oerlikon. In the preface the author appears to claim that his work is of a more practical character than existing works on the subject, and that it will therefore be of greater use to those who have to take up the actual designing of dynamo machinery. We can hardly endorse this claim, for although the book is undoubtedly a valuable one, it is more likely to be used in conjunction with, rather than in place of, existing standard works.

In Chapter 1 the fundamental principles on which the design of dynamo machinery is based are described in a manner which is commendably brief and clear, and in Chapter 2 the design of armatures is gone into very fully; diagrams are given of the systems of ring and drum windings mostly in use, eccentricities and historical examples being sensibly omitted. Armature reactions and sparking are briefly mentioned, being more fully treated in a later chapter. Sayer's and Mordey's methods of winding are described, but in a manner which is not very full or clear, and one of the principal advantages claimed by these inventors, namely, the reduction of gap excitation and leakage, and consequent saving in iron and copper in the magnetic circuit, is not mentioned at all. Later in the book an example is given of a dynamo constructed on Sayer's system, and attention is drawn to the lightness of the machine, but without any cause for this lightness being assigned. Calculations for the various sources of loss in connection with the armature are given, including the frictional losses in the bearings; it is doubtful, however, if the calculation of these latter is of any practical importance, depending as it does upon a coefficient of friction, the value of which may be greatly varied by a change of lubricant, or even by a change of the rate at which the lubricant is fed. Efficiency and heating are next dealt with, and the chapter concludes with examples of the calculation of armatures for a given output, and with a table giving the leading dimensions of a number of armatures of existing machines. Chapter 3 is entitled "Design of Field Magnets." It is a very comprehensive chapter, and deals with a wide range of subjects. Calculations for series and shunt magnets are given, and here we notice a repetition of the old error that in a dynamo the armature reaction opposes the excitation, while in a motor it assists it. To obtain sparkless collection dynamo brushes must be moved forward, and motor brushes backward, and the forward movement of the brushes in the dynamo and backward movement in the motor both produce opposing ampere-turns in the magnetic circuits of their respective machines; therefore in a motor the armature reactions weaken the field, although not generally to the same extent as in a dynamo of similar size, as the angular movement of the brushes necessary for sparkless collection is less. Tramway motors are very fully treated, and graphic methods are given for solving the various problems in connection with them. In connection with shunt wound motors an excellent arrangement of starting switch is described, which when stopping avoids interruption of the shunt circuit and so prevents damage to the insulation of the coil. The same arrangement was described in the Electrical Review some years ago, and it is surprising that engineers in this country have not taken it up. In this and in the preceding chapter the author devotes considerable space to a description of the method of calculating the windings of a new machine by proportion from the windings of an existing machine. Although it does not appear to be the author's intention, still we think that the prominence given to this method is liable to produce in the mind of the student an impression that this antiquated procedure is still in vogue in place of the accurate and expeditious Hopkinson method by which windings can be calculated without reference to previous machines. Chapter

4 gives a description of an ingenious permeameter of the author's design. Chapter 5 and section F of chapter 4 should be taken together as they relate to the calculation of magnets by the Hopkinson system, and to the tracing of the characteristic curves. Examples with diagrams are given both for magnets with single and double magnetic circuits and the effect of leakage is also fully considered. In connection with this chapter a table of leakage coefficients for various types of machine is placed at the end of the book. The values given are a little higher than our experience has shown, but this is in any case an error on the safe side, and would only lead to the speed of the machines coming out a little slower than that calculated, a matter to which customers do not usually object.

Chapter 6 is an interesting and suggestive one on the subject of armature reactions and sparking. A number of formulæ are given, and there is also a table in which these formulæ are applied to a number of existing machines, some of which the author tells us work well, and some badly.

Considering that calculations of this class have to depend upon arbitrary constants, it appears to us that they might be less elaborate, and a simple and definite relation established between ampere-turns per coil on the armature and the strength of reversing field required to effect sparkless collection, constants being obtained for different types of machines. In this chapter there are described and illustrated several methods for balancing more or less effectively the cross turn reaction of armatures.

Chapter 7 describes several forms of machines for special purposes, and Chapter 8 is an extremely good one on the mechanical construction of machines. Sectional drawings are given of the different parts, together with formulæ for the determination of their correct proportions and sizes. Among other details sectional diagrams are given of ball and roller bearings, and their advantages and disadvantages are fairly considered. A valuable section of this chapter is that relating to the formation of block windings for armatures, drawings being given which show the construction and method of using the wooden formers upon which the armature coils are wound.

Chapter 9 is one which will be studied with interest by dynamo designers, containing as it does a large collection of well-executed and clear sectional drawings of machines of different sizes and types, most of them being of Continental manufacture.

Chapter 10 contains particulars of the weight and cost of machines, and Chapter 11 concludes the book with a recapitulation of the principal formulæ to be used in the design of dynamos. At the end of the book are a number of tables and curves, also a diagram sheet of the different types of magnetic circuits to which reference is made in various parts of the text, and there is a very full index. Without wishing to detract from the value of this work, we certainly consider that its study would have been rendered more convenient and expeditious if the author had adopted for his dimensions the English units of inches, lbs., &c., instead of the Continental ones of centimetres, grammes, &c. As it is, the perusal of the text has to be accompanied by a continuous translation of the dimensions into English units, and we think this would have have been better if done by the author in the first instance. We would also suggest that in future editions a table of all the symbols used should be given, as when using the book as a work of reference it is a great waste of time to continually have to hunt through back pages to find out what the symbols are intended to represent. If the table were printed on the outer flap of a double leaf it would, when extended, lie outside the volume and could be referred to without having to turn over the leaves. These criticisms refer to comparatively small matters and do not affect the value of the work as a whole; in conclusion, we may say that we consider this to be a very good work, and that it should be possessed by everyone who wishes to be up to date in the design and construction of dynamo machinery.

Wireless Telegraphy.—On Saturday last Mr. Ritchie, the President of the Board of Trade, inspected the Marconi apparatus at the South Foreland, its action being explained to him by Mr. Marconi.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1899.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, *to whom all inquiries should be addressed.*

7,041. "Improvements in electric arc lamps." G. St. John Day. Dated April 4th.

7,105. "Improvements in apparatus for controlling the reversing mechanism employed in telegraphing and the like by means of electrical rays or waves." A. Orling and C. G. G. Braunerhjelm. Dated April 4th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, February 27th, 1899, being date of application in Sweden.)

7,144 "A new or improved electric apparatus for automatically regulating the physical condition of gases and liquids." H. Schultz. Dated April 5th. (*Complete.*)

7,179. "Improvements in long distance electric signalling." D. V. Riordan. Dated April 5th.

7,204. "Improvements in electric motors and accessories in connection with coin-freed and other electricity meters." J. Readman. Dated April 6th.

7,277. "Improvements in or connected with apparatus for measuring and recording electric currents." H Aron and Aron Electricity Meter, Limited. Dated April 6th. (*Complete.*)

7,284. "Improvements relating to telegraphic, telephonic, and like systems, and to automatic switching apparatus therefor." L. J. M. Dardeau. Dated April 6th. (Date applied for under Patents, &c., Act, 1883, Section 103, October 10th, 1898, being date of application in France.)

7,321. "Improvements in secondary battery plates, grids, and the like." W. A. Gent. Dated April 7th.

7,326. "Improvements in electric telephony." C. Adams-Randall. Dated April 7th.

7,339. "Method of operating typewriting, composing, or similar machines by means of electro-magnetism." E. Trowe. Dated April 7th. (*Complete.*)

7,345. "Improvements in multiple-contact telephone transmitters and the battery-circuit or circuits relating thereto." C. Adams-Randall. Dated April 7th.

7,354. "Improvements in dynamometers." G. J. Gibbs Dated April 7th.

7,364. "Improvements in or relating to means for controlling and indicating the supply of electrical energy." H. Kunkelmann, C. E. Francois and C. R. Loubery. Dated April 7th.

7,371. "Improvements in electric safety devices." G. K. B. Elphinstone. Dated April 8th.

7,415. "Improvements in electrical cooking apparatus." J. B. Cary and M. Cary. (V. Delevy.) Dated April 8th.

7,416. "Improvements in electricity meters and in prepayment mechanism for the same." G. Hookham. Dated April 8th.

7,427. "A correcting transformer for simple or polyphase alternating electric currents." J. Imray. Dated April 8th. (La Societe Anonyme pour la Transmission de la Force par l'Electricité, France.)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free,* 9d. (*in stamps*).

1897.

130. "Improvements in multiplex telegraphy." J. M. Barr Dated January 2nd, 1897. Multiplex systems in which alternating currents of uniform periodicity are imposed on the line. The subscribers' instruments are arranged in pairs, so that the product of their capacity and self-induction gives a constant of such value that electric resonance is obtained with the imposed currents. As the capacity or self-induction of each subscriber's instrument is different, it is necessary, in transmitting, to employ a transmitter of such a character that it, together with the called subscriber's receiver, shall give the required constant of capacity and self-induction. 1 claim.

907. "An improved device to be used as an indicator signal or relay in connection with telephone switchboards and other analogous apparatus." P. Rabbidge Dated January 12th, 1897. Indicators or relays for use with telephone switchboards, &c. A permanent magnet has one fixed polar extension and a sliding polar extension, which are held together by mutual attraction against the force of a coiled spring. The parts separate when a signal current is received by the opposing coil. The free end is formed as a push and a collar arranged to close a local circuit through contacts. The push may act as a visual indicator or operate a rotating label or shutter. In one form the magnet, A, may be a steel spring with the soft pole pieces attached; in another form a bar magnet is provided with soft iron polar extensions. 6 claims.

995. "Improvements in galvanic batteries." W. S. Doe. Dated January 13th, 1897. Portable sealed batteries for lighting electric lamps on bicycles and for other purposes. The battery which comprises a casing closed by a cover, and divided into compartments by partitions communicating at the top through openings. Each compartment constitutes a separate cell, in which is placed a perforated carbon cylinder, open below and closed above, and from the cover are suspended perforated rubber tubes, in which is placed a split cylindrical zinc tube, in which is placed a depolarising cartridge of sodium nitrate. The cartridge is pressed down on to the ends of conducting wires by springs fixed to caps, which fit on the ends of the tubes, the said wires being supported by rubber pins. The electrolyte may be dilute sulphuric acid. Gas exits closed by spring caps are provided in the covers. The current may be broken by a switch fitted on the conductor from the carbon. 5 claims.

1,465. "Improvements in perforators for telegraph transmitting ribbons and the like." E. R. Storm. Dated January 19th, 1897. Perforating machines for preparing telegraph transmitting ribbons, &c., are formed with keys which operate through pivoted levers and links to cause catch levers to hook over a raising bar. The levers are pivoted to bars provided with projections corresponding to the perforations to be produced for any signal. The projections operate on transverse bars, so that when raised the particular bars carry with them their links to actuate the spacing and perforating mechanism. The positive actions of the machine are performed by power through a fly-wheel and driving pulley, which are connected to a shaft by means of a clutch when the operations are to be performed. The shaft is provided with the necessary cams for operating the various parts. The punches are mounted in slides and are operated by a carriage receiving motion from a cam. The punches are selected by means of sliding bars operated by the links, the bars being inserted as a backing behind the particular punches employed. The spacing mechanism consists of a ratchet wheel having projections for the central row of perforations, or a pressure roll when no such perforations are employed, and an operative rack thrown in and out of gear by a cam lever, which, when it frees the rack, locks the wheel. The movement of the rack is limited by a number of pivoted bars whose rear ends form a rack. The bars interlock in one direction and are operated by other bars controlled from the keys, the number of the bars moved depending on the perforations required for any signal. The paper is fed from a spool provided with a ratchet wheel and pawl, and passes over guides and through a clutch or gripping jaws before reaching the punches. Spaces are produced by two keys, one operated with any signal key so as to produce the spacing perforations simultaneously with the signal perforations, and a second operated separately to produce spacing perforations only. 44 claims.

1,771. "Improvements in electrically driven sheep shearing or hair clipping machines." W. Baines and W. Norbs. Dated January 22nd, 1897. The clipper is worked by an electric motor in an aluminium case. The current passes from binding screws through copper brushes to collector rings on an ebonite disc, a push-piece being inserted to make or break the current. There is a stationary armature and a revolving field fixed to the spindle. Within the barrel commutator revolve the brushes, consisting of arc lamp carbons. The lever attached to the upper cutter is worked by a crank pin on a disc adjustably and eccentrically mounted on the shaft, thus giving an adjustable throw to the crank. The motion of the current may also be varied by making the fulcrum pin adjustable along the lever. 3 claims.

2,378. "Improvements in and relating to primary batteries." W. Rowbotham. Dated January 29th, 1897. Relates to a carbon-iron cell in which a mixture of sulphuric and nitric acids, or nitrates, is used as the depolariser. A large number of tubes of porous material connect the partitions and open at one end into the sealed chamber. Carbon rods are contained in these tubes, are connected together and to the terminal by metal strips embedded in cement. The iron plates are arranged between successive vertical series of porous tubes. Water is circulated through the chambers of successive cells, and the depolarising liquid through the chambers. The cells are arranged in steps, the water and depolariser flowing from one to the next through air gaps. The pressure of the nitrous fumes generated at the carbon rods forces the exciting liquid through the porous tubes into the chambers in proportion to the amount of gas generated. (Patent not yet due for sealing.) 2 claims.

2,534. "Improvements in or relating to systems of electric traction." R. Belfield. (G. Westinghouse, U.S.) Dated January 30th, 1897. Relates to electric railways and tramways. Different parts of the line are worked with overhead or underground conductors or with batteries, to suit the local condition of urban, suburban, and country traffic. The batteries may be charged from the conductors and may supplement them. One part consists of a road contact system, with electro-magnetic switches, which may be employed. A shunt current flows from the collector through the studs to the return to throw the switches in order to connect the main conductor to the second series of power supply studs. 4 claims.

2,801. "Improvements in electrical transformers." A. F. Berry. Dated February 2nd, 1897. The core is formed of a number of L-shaped plates alternately inverted and arranged in radial grips, the centre being hollow. Intermediate grips with narrower plates are also fitted, and are held in position by wooden blocks. The core is clamped between perforated end plates, so as to allow a free circulation of air. The whole is enclosed in a casing fitted with a cover. In building up the transformer, the L-plates are first placed in position on a central core or mandrel, then the insulating layers are fitted, next the coils (suitably insulated), and finally the L-plates to complete the core. The mandrel is then withdrawn and spring tubes inserted, the transformer being then completed as above described. 2 claims.

3,488. "Improvements in secondary batteries." E. Schattner. Dated February 10th, 1897. Plates or electrodes to be used in a horizontal position are made up of a lead grid, which may be corrugated and has slots therein. The grid is covered on both sides with active material, which is in turn covered with a flexible, porous, and acid proof material, such as paper dipped in tungstate of soda. Outside the paper are placed rigid perforated slabs of porous earthenware, prepared wood, or other material, the slabs on opposite sides being laid at right angles to each other, and the whole is held together by strips of rubber cemented to the slabs. The perforations in the upper slab are larger than those in the lower to allow of the escape of gas. 4 claims.

3,812. "An improved current collector for use in connection with electrically-propelled vehicles, and for like purposes" A. Heusch and P. Brandt. Dated February 12th, 1897. Relates to collectors for use with overhead conductors. A disc supported on a rod by a ball and socket or other joint, is pressed against a conductor by springs. 2 claims.

4,330. "An improved incandescence electric lamp for advertising purposes." I. Paprian. Dated February 17th, 1897. Relates to means for advertising or attracting attention by means of incandescent electric lamps. The bulb is made with stripes or chequers of different colours, as shown, and is mounted underneath a reflector made in sections. The lamp is supported in a wall, &c., by a pin, connected to a toothed wheel, which is rotated by a motor. The lower part of the pin is connected to one filament terminal and the upper part to the other, and the connection to the leads is made by brushes. 2 claims.

4,391. "Improvements in electric heating devices." W. E. Heys. (A. D. Chedville, France.) Dated February 18th, 1897. Relates to electric stoves. A resistance wire is wound on a notched sheet of asbestos board, or on an asbestos tube. The ends of the resisting and connecting wires are clinched by eyelets. The sheet is then enclosed between two other asbestos boards, which are attached with silicate of potash. A tube may be enclosed in another asbestos tube. The whole is then placed in a metal case, which may be of sheet metal, folded and joined at its edges. Such heaters may be used in electric and other vehicles. 1 claim.

1898.

16,677. "Improvements in and relating to desk telephones." M. Byng. Dated September 28th, 1898. Relates to improvements in telephone for desks. Consists of a box which carries the various connections, an audible signal, such as a buzzer or bell, and a transformer within it. Outside is a bar carrying a sliding contact which may make contact with any of the contact knobs, a finger being attached to show the point or station of communication. An index is fixed to the case. The figures are printed or formed upon discs let into countersunk holes in the bar. Two hooks support a combined transmitter and receiver when the apparatus is hung on a wall, desk, &c. When the combined microphone transmitter and receiver are in use, a pressure switch establishes and maintains the requisite contacts. 5 claims.

17,622. "Method of manufacturing incandescent electric lamps." C. A. Allison. Dated August 12th, 1898. Consists in flanging two tubes at one end only, one tube being larger than the other, softening the free edge of the larger, and drawing out the edge at predetermined points to form outwardly extending folds, inserting in said folds the combined copper and platinum terminals at their points of junction and sealing them there, uniting the corresponding poles of the filaments, placing the inner tube within the outer, sealing the edge of the flange of the inner tube to the inner edge of the outer tube, sealing the edge of the flange of the outer to the edge of the neck of the bulb, exhausting the air from the bulb, through the inner tube, and finally sealing the inner tube. 4 claims.

17,825. "A new or improved porous plate, body, or electrode." W. H. Beck. (J. Johnson and J. Robertson.) Dated September 24th, 1898. Electrodes or porous plates are prepared by taking, for instance, lead, and heating it until it is melted, adding powdered or naturally porous substance, such as pumice stone. The pasty mass formed is then kneaded, similar to making dough. Whilst still in a pasty condition, it is moulded into any convenient shape, according to the uses to which the plate or body is required. 6 claims.

17,984. "Improvements in and connected with electric railways and tramways." E. Warwick. Dated August 19th, 1898. Relates to improvements in electric railways and tramways, particularly to the construction and arrangement of the trolley rail. When underground, the conductor is clamped by insulating blocks to brackets on the yokes, or is supported on insulating pieces placed in channel iron troughs running from yoke to yoke. Where the ends of the conductor meet together he provides a metallic coupling piece which is insulated from the trough or contiguous metal parts. In a surface system the troughs are so formed as to permit of their being secured to the railway sleepers. In this case, as the conductor would be more exposed and unprotected than in a conduit, it is embedded in asphalt or other suitable insulator so that only that portion which comes in contact with the trolley wheel will be left naked. 5 claims.

20,418. "Improvements relating to motors for electric railways." S. H. Short. Dated September 1st, 1898. Relates to motors for electric railway cars. Consists of the armature and shaft of a multipolar motor in combination with a supporting frame for the magnetic poles of the motor field, said frame having bearings formed within the outer periphery of the magnetic ring of such field, the axle arranged to be received in said bearings, and intermeshing gears mounted respectively on the shaft and axle. 5 claims.